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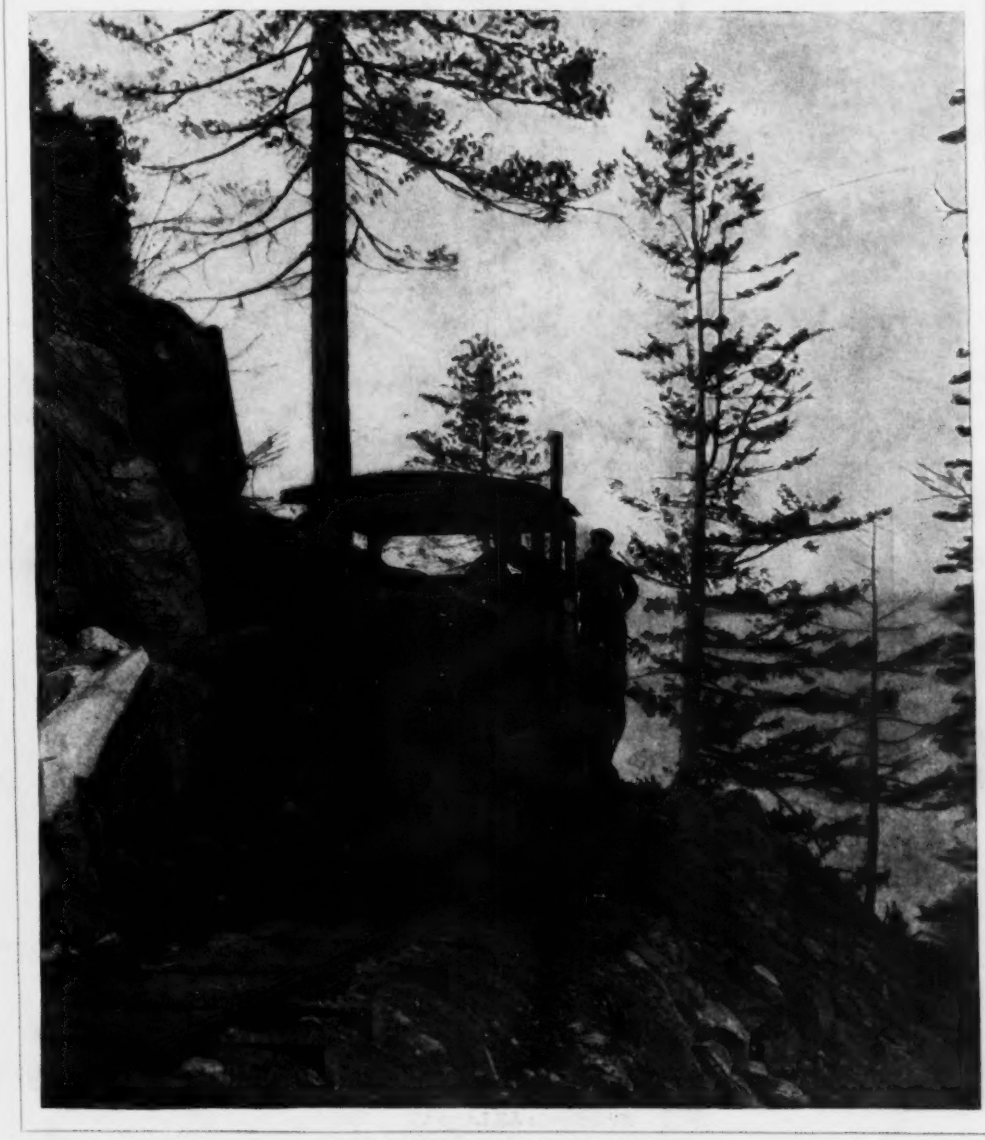

Hauling Supplies to Inaccessible Dam Site

High-Head Hydro-Electric Project on Bucks Creek in California

Road Building Problems and Practices in the Oil Fields

Ferric Salts as Coagulants for Activated Sludge

High Strength Steel for Modern Bridges

Staff Report of the Annual Meeting of the American Society of Civil Engineers

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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General Manager
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Goethals of Panama

WITH George W. Goethals, builder of the Panama Canal, American engineering loses a strong, inspiring and picturesque figure beyond compare. Himself known to but few, he made his name familiar to the entire world; it is likely to live as long as his canal. He wrought his fame in half a dozen years of tremendous achievement, pushing a great cut through the hills from ocean to ocean and piling up the huge dam at Gatun. What he did in the years that preceded and followed, though itself a lifetime of productive work, vanishes in comparison. The greatness of his work was emphasized by its dramatic circumstances. Goethals was called to the Panama task at a time when the government had reached a crisis—when its own bureaucratic muddling joined with Nature's formidable obstacles had made the enterprise seem hopeless. Preparatory work of remarkable excellence had been done, but its meaning was obscured by red tape and discord; a leader was needed, an organizer and autocrat. Goethals was the man of the hour. Able soldier and brilliant engineer, he assumed command of the situation in a manner that swept aside all bureaucratic interference and delay. He gathered around him men of ability and faith, with power to accomplish the new things required, and faith in his leadership. A keen judge of men and of physical facts, he directed wisely both the plan and the working army. And so the brusque and uncompromising West Pointer became the idol of his fellows and the admiration of the world. That time is now many years gone. Long afterward we heard of Goethals as the man who damned the "long, narrow and wooden" boards of the early war period; still later he was one of those who helped to guide the great Hudson River bridge plan along a sound course. But the Goethals of history is Goethals of Panama, the man who drove and did, and thereby built the Canal.

For Technical Advance

TWO notable facts in conjunction give quite special distinction to the meeting of the American Society of Civil Engineers, just closed. First, this meeting saw an effective demonstration of the vitality of its technical divisions. The division sessions revealed the energy with which the specialist groups are developing the interchange of information in their several fields; and while not all of the sessions were of marked strength, each one was characterized by this constructive activity. Nevertheless—and this is the second notable fact—the society authorities have set in motion a study for still further improvement of the technical activities. The Board of Direction resolved on the appointment of a committee to survey the whole field of the society's technical work, from publications and meetings to research, with a view to stimulating and co-ordinating its component elements. The decision invites hearty approval. To plan for improvement at a time of good progress is prudently wise. The desire for even better progress is evidence of an innate vitality which assures continued advance; it strengthens the hope which we expressed last week in speaking of the society's anniversary celebration and its meaning for the future.

New Educational Ideas

A STEADY increase in college attendance is reported from all over the country, and engineering schools and courses appear to have their proportionate share in this growth. Correspondingly, everyday experience proves that there is no dearth of recruits to the engineering field. The lower ranks of the profession are more than fully manned; supply exceeds demand. In these conditions it is especially interesting to hear that a new plan of technical education is to be put under study by the Society for the Promotion of Engineering Education. The scope of the study has been announced, though in general terms only. As we understand it, the objective in mind is a more practical, more business-like course of training, with a view to supplying a demand for men rather differently equipped from the present engineering college graduate. While the particular field of work which the new educational program would supply is not clearly defined, we may conclude that when it is decided to carry the new educational plans into effect they will tend to increase further the supply of school-trained technical men. The desirability of such increase is far from demonstrated, we believe. Possibly the increase could be avoided by making an attempt to meet the specific demands underlying the new plan from among the present technical college output. Since the curricula of today can hardly be charged with giving too thorough a training, there would seem to be real opportunity for developing a special product through short substitute or supplementary courses attached to the existing courses for such of the undergraduates as might elect them. Under present conditions, an innovation in technical education that would increase the cadet ranks promises to be more disruptive than helpful.

A Purchase Option

PUBLIC hearings in New Haven, Conn., on whether the city should exercise its option to buy the works of the New Haven Water Co. next month call attention to the fact that New Haven is the only city of size in New England and one of a few large cities in the United States that does not own its water-works. The company was frank enough to announce, when the necessity for decision as to the option was brought to public attention by the mayor, a few weeks ago, that it considered a rate increase necessary and proposed to apply for it officially.

The resulting discussion has brought out the fact that the city is entitled to and gets water for public purposes without charge. Water consumers do not seem to be awake to the fact that this "free" water for public purposes means higher rates to private consumers. Such a condition is against sound public policy and would not be permitted in some states. An apparent general apathy on the subject of purchase will presumably give way to more public interest if the significance of the unjust distribution of the water supply burden is brought out. Public interest is also likely to be increased by two recent announcements: (1) That the company says it needs an increase of 33 per cent in meter and 43 per cent in flat rates; (2) accountants employed by the city report that the existing rates in New Haven more than provide the 8 per cent return on investment to which the company is entitled. The outcome of all this discussion at New Haven will be awaited with interest. Properly interpreted, it should help to throw light on some phases of public-utility service that are often disregarded.

Concerning Legislative Freedom

IN A stimulating address before the American Engineering Council at Washington recently, Dean Dexter S. Kimball, of Cornell, introduced a contrast—perhaps unintentional—that invites some reflection. He spoke of the theoretical and always desirable freedom of legislative thought, the ideal state in which the legislator has in view solely the best interests of the country as a whole and is free from influence by special considerations. He referred with implied deprecation to congressional groups or "blocs," whose aim is to uphold some particular point of view, favoring one class or region. The "farm bloc" was specially mentioned, as is perhaps not unnatural in an Easterner's address. Though he admitted that these groups are more or less effective by their indirect methods, the outstanding problem of democracy, he said, is to call to its aid the specially trained. Accordingly he stressed the desirability, even necessity, of an engineering organization designed to influence legislation—referring of course to the American Engineering Council. In comparing the two thoughts one does not find it altogether easy to reconcile them. The concept of free, uninfluenced legislative action is no more compatible with the institution of the lobby than with the institution of the bloc. True, the lobby is an extra-legislative organization and therefore differs in an essential respect from a bloc within Congress. Yet its aim is to bring about a result quite like that which the latter accomplishes—namely, to give special weight to a particular interest or a single, specialized point of view. In short, even an engineering lobby is subject to some of the arguments that Dean Kimball implied against congressional blocs. An ideal state of legislative organization would allow at most a citizen lobby, and even this might be subject to challenge. But we recognize that practical facts disagree with so idealistic a situation. Lobbies—educational, perhaps, but still lobbies—are a firmly fixed part of present-day legislative organisms. Perhaps it is well that they are so thoroughly established, for in the fully developed system none but the useful and efficient lobby can survive to any effect. If, however, the lobby is thus justified by present-day conditions, it may also be that the bloc is justified and serves some useful purpose. At all events, its denunciation in an engineering discussion does not invite unquestioned approval.

High Finance

THE financial history of the Chicago, Milwaukee & St. Paul Railway Company as revealed in the investigation conducted by the Interstate Commerce Commission following the bankruptcy is a record of sordid business dealing. It tells of great banking houses using their intimate association with the railroad company to help fill their own coffers, of directors taking no interest in the property they were supposed to control, of other directors betraying their trust and of railroad managers keeping the price of the railroad stock at a high level by paying dividend rates not justified by the income of the property. In fact, the whole record is but a repetition of what occurred many times in the past, during the days when railroad properties were but pawns in the hands of railroad magnates who maneuvered them to suit their own ends and with little regard to the primary purpose of the railroad. Moreover, even now, despite all the safeguards of the transportation act, at least one of the commissioners believes that the plan of reorganization which has been approved by the commission and the courts is written more in the interest of stock speculators than of the railroad property as a whole.

In March, 1925, the railway went into the hands of receivers. It was the largest of such failures in the history of the country, and in addition was the failure of a company whose securities had, in the past, been considered gilt-edge. There was widespread belief in the country that there was more behind the failure than appeared on the surface, and as a consequence the Interstate Commerce Commission in May, 1925, started an investigation of the railroad's financial history. At the same time the receivers began making plans for a reorganization of the property. On Jan. 4, of this year, the commerce commission approved the plan of reorganization and made public its findings in the investigation of the railroad. As already remarked, they form an unsavory record.

The findings outline the financial downfall of a great railroad property, beginning with its extension to the Pacific Coast not so much because the extension was needed as to meet competition with other powerful railways. The work was done at the peak of a railroad expansion period, when high costs and other factors carried the cost of the project far beyond the original estimates. Money needed for construction was raised by bond issues when the stock of the parent company was selling far above par. Vast areas of land along the new line were bought as a speculative venture. Then came a period of depression. In order to keep up dividend payments on stock, borrowed money and quick assets were used for that purpose and the property was allowed to depreciate greatly. Meanwhile some of the executive officers died and others having less financial experience were appointed. The banking house which had handled the company's securities for years was not asked for, or else failed to give, advice in matters of financing. To further complicate matters, two connecting railroads in impoverished circumstances were bought at prices far above their apparent value, in an ill-conceived plan of expansion.

Some of the directors had no financial interest in the railroad other than their qualifying shares of stock, and many of them took no active part in managing its affairs. Of the few directors who did take an active part, the findings makes it appear that John D. Ryan conducted himself more as if his activity was in his own

interest rather than in that of the railroad. When plans for electrification were in progress, he bought from the railroad company its interest in valuable power sites, and, after a power company organized to develop the sites (the Thompson Falls Power Company) had made a 99-year contract with the railroad to supply it with power, he turned over to it his interests acquired from the St. Paul, receiving in return $5,000,000 par value of stock of the power company, which he immediately exchanged for an equal amount of stock of the Montana Power Company. Of this transaction the Interstate Commerce Commission says: "Ryan and his associates did not expend over $925,000 for the property for which they received $5,000,000 nominal par value in stock of the Montana Power Company. The principal thing that gave value to the stock of the Thompson Falls Power Company was its contract with the St. Paul."

The depression which occurred in the Northwest following the war brought matters to a climax, and as a last maneuver in the whole unhappy proceedings the banking houses which had profited so much through handling the railroad's securities in the past and had given so little much-needed advice stepped in and had themselves appointed reorganization managers. They prepared a plan which the Interstate Commerce Commission now grudgingly approves, not because it thinks it is a good plan but simply because it thinks that it is better to end the receivership than to have it continue through all the litigation incident to the preparation of a better plan.

The picture is indeed a dark one. Many people had come to believe that the days of manipulating railroad property for private gain were of the past. This record indicates that they are not wholly gone.

Still Unsolved

WHAT to do with sewage sludge, and how to do it are troublesome questions of the day in the sewage-works field. Every new process of treatment brings a train of problems peculiar to itself and, worse yet, these problems vary from city to city, for the sewage of each city is a law unto itself. The advent of the activated-sludge process was hailed by those optimistically inclined as a solution of the sludge problem, but at the comparatively few activated-sludge plants where attempts have been made to dewater the sludge for the sake of its high nitrogen content there has been no end of trouble. Perhaps the most hopeful prospect just now lies in conditioning the sludge for pressing by the use of ferric salts, as discussed on page 147 of this issue by chemists of the Chicago Sanitary District. The article reviews research studies by the authors and notes experiences at several other places, notably at the Milwaukee activated-sludge plant, where for some months chlorinated copperas has been used.

Regardless of the process by which sludge is produced and whether or not it is to be dewatered before final disposal, in some cases it is already being pumped long distances. A sludge force main 18 miles long is under construction by the Chicago Sanitary District. Confronted with the design of such force mains, engineers have found available few data as to friction. At last week's meeting of the Sanitary Division of the American Society of Civil Engineers a committee report on the subject was submitted. The report included summaries of sludge friction tests at Baltimore, Syracuse and Chicago, which, while promising to be helpful, were notable more as showing the need of further study than as being conclusive. The report indicated different friction factors for sludge from different processes—for instance, from Imhoff tanks and from activated-sludge plants. They also indicated, as would be expected, friction values varying with moisture percentages.

The studies suggest a whole series of questions as to sewage-works design where sludge is to be pumped, or for answer before deciding whether it shall be pumped or the process of treatment be carried to a finality at the point of origin; and so at the seventy-fifth annual meeting of the American Society of Civil Engineers the sludge problem is decidedly more urgent and presents more points for discussion than it did when the society was formed; notably so in America, for in 1852 sewage treatment had hardly been thought of in this country or elsewhere outside of England, and was in its early beginning there.

Non-Parking a Success

FROM the standpoint of traffic and the interests of the general public, the first few days of Chicago's non-parking ordinance, which went into effect Jan. 10, have proved a marked success. Increased clearness of the streets, rapid and steady traffic movement and elimination of tangles and congestion became conspicuously evident. In fact, automobiles soon began to move so fast that, in the interests of pedestrians, the police authorities reduced the speed limit within the district affected.

The ordinance applies to the greater part of the central business district, including the congested "loop" section. To carry it into effect, numerous "no-parking" signs were put up and extra police were on hand at first. Some of the policemen were soon withdrawn, however, as careless or chance-taking violators of the rule were fewer than had been expected. Retail stores put advertisements in the daily papers giving the location of convenient garage and parking space or noting special arrangements for taking care of patrons' automobiles, and posted copies of these advertisements throughout their establishments.

Cleanness as well as clearness of the streets is evident, since the cleaners are not obstructed by parked cars and by the papers and refuse that accumulate under them. Cartage delivery of freight is said to have been expedited materially, as well as the movement of taxicabs and buses, while street accidents were reduced. No doubt many automobilists chafe at the inconvenience or expense of seeking parking room (free or otherwise) instead of using the public streets, but against that objection may be set their much greater freedom and speed of movement in and through the city.

One uncertain feature is the effect of non-parking upon retail stores. Although previous traffic counts have shown that comparatively few of the shoppers came from parked automobiles, several merchants opposed the ordinance as likely to reduce their business. Some of these are already complaining that this has resulted, but others seem to find little effect, while official checks at some establishments have shown no material change. However, the effect of the non-parking rule in this respect cannot be determined definitely until after at least a month's experience. From the traffic point of view the method has proved even more successful than was expected.

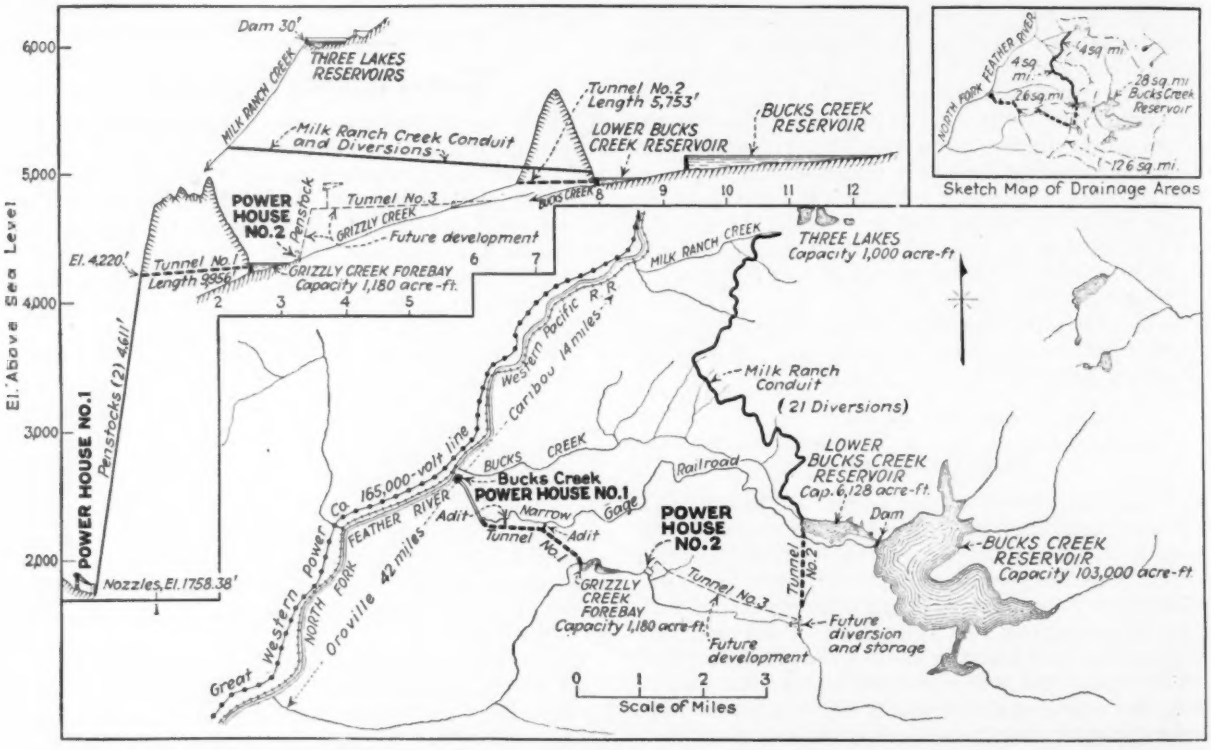
High-Head Hydro-Electric Project on Bucks Creek

Variety of Operations Involved in California Power Development That Will Utilize Record Head of 2,561 Ft.

THE BUCKS CREEK project of the Feather River Power Company, which is being constructed on a branch of the Feather River about 30 miles northeast of Oroville, Calif., will develop 70,000 hp. in two impulse turbines operating under a head of 2,561 ft. (static). In addition to this record head, interest attaches to the project as a whole because of the diversity of the work to be done, seventeen separate contracts or major features being under way at one time.

Such a variety of operations going on simultaneously has placed special importance on co-ordination, without output of the Bucks Creek plant has been sold to the Great Western Power Company under a contract by which the latter company takes delivery of the power in the power house, transmitting it over its own transmission line to a connection with the company's system.

Some idea of the roughness of the topography may be had from the fact that the average slope of the 4,800-ft. penstock is 30 deg., this being typical of the region. The logical starting point for transportation to the upper parts of the project was at the top of the penstock where the tunnel begins. Because the penstock would require



PLAN AND PROFILE OF FEATHER RIVER POWER COMPANY DEVELOPMENT NOW NEARING COMPLETION

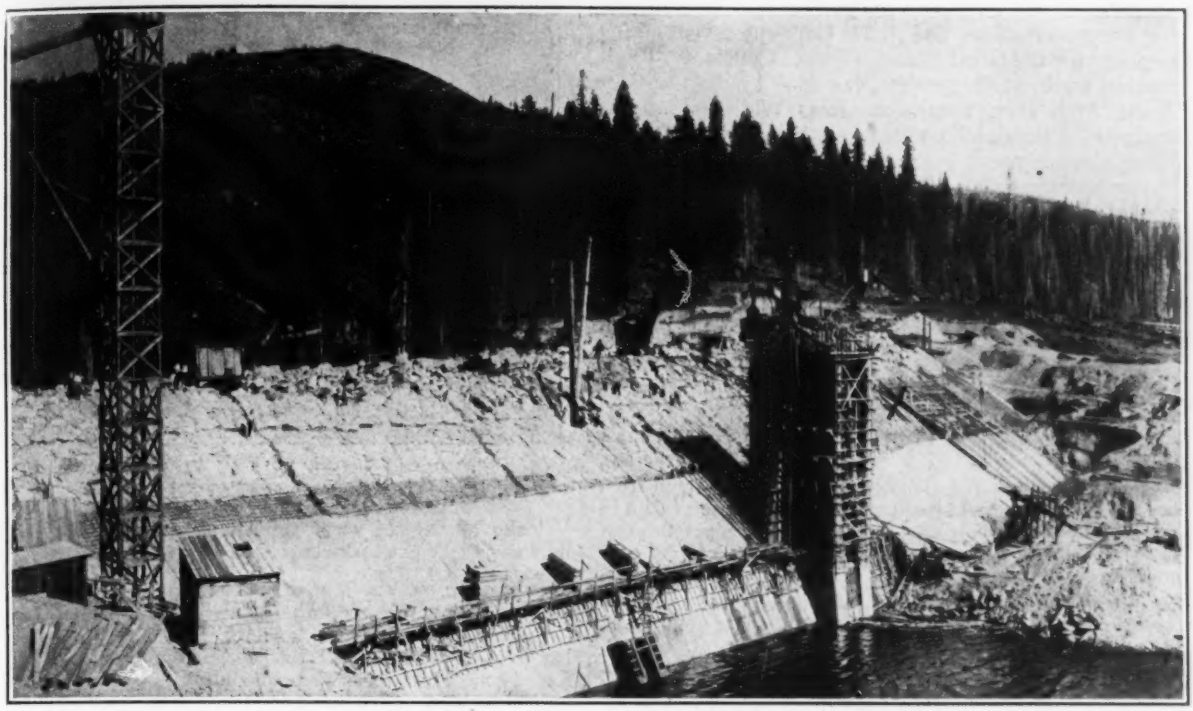
which the development as a whole could not proceed expeditiously and be ready for operation on schedule time. Included in the project are the construction of 18 miles of roads, a 10-mile railway, a 4,800-ft. incline, several dams, two tunnels, 8 miles of welded pipe, various headworks, a surge chamber, penstocks and power house, not to mention the preliminary and incidental work involved in carrying on such operations in a remote region of rough topography where at times as many as 1,200 men were employed.

The contract for the project as a whole was signed late in 1925. Work was pushed, particularly on the tunnels, during 1926 and activity of the widest scope was attained during the summer of 1927. By Jan. 1, 1928, the greater part of the work on all major features had been completed except in the case of the Milk Ranch conduit and it was expected that the power house would begin to deliver during the summer of 1928. The entire

an incline close by it for placing the pipe sections, one incline was built to serve both this purpose and that of delivering materials and equipment to the works under way beyond. This incline has a total length of 4,800 ft. and a maximum grade of 48 deg. It is of the funicular type, a car being on each end of the cable so that one always goes down as the other goes up.

The electric hoist at the top is operated by a 200-hp. motor and the equipment as a whole is designed to handle fifteen-ton loads with a rope speed of 300 ft. per minute. The track is of standard gage, three rails being used to form two tracks, except at the midpoint, where there is a short length of double track to permit the cars to pass. The use of three rails keeps the cable to one side of either car that may be above the other car, thus avoiding danger at those points where the cable rises due to dips in the incline grade.

From the top of the incline a 10-mile narrow-gage



THE ROCK FILL STORAGE DAM ON BUCKS CREEK
Note steam shovel with dipper removed used in placing large pieces in the rock facing.

railway was built extending to the main storage dam and passing en route several points where construction was carried on. This railway, built along the face of a very steep granite slope, contains curves with radii as short as 24 ft. Gasoline locomotives operated on this line took an average full load of nine tons of freight on two flat cars.

In addition to the narrow-gage railroad about 18 miles of motor-truck roads with maximum grades of about 12 per cent was built extending from the top of the incline to Grizzly Creek forebay dam and to all parts of the higher level operations. Materials and equipment used in these upper level operations had to come up the incline and be transshipped to flat cars or trucks for delivery. Cement for the two dams, pipe for the 8-mile conduit and construction equipment constituted the three major freight items.

HAULING SUPPLIES TO THE UPPER END OF THE JOB
This railroad follows a sinuous line and skirts many cliffs between incline and intake.

The entire 8 miles of the Milk Ranch conduit, which connects two of the drainage areas, is being put together by oxyacetylene welding. The route followed is so devious that bevel cuts are required on practically all joints in the line, although the pipe sections are only 14 ft. long. The lengths are reduced to 7 ft. in the gullies to keep the angularity at joints within the prescribed 15 deg. maximum.

Makeshift Equipment Utilized

Because of the difficulty of delivering equipment to the upper end of the work, it was often more economical to use such equipment as was available rather than to bring in other equipment better suited to the particular work to be done. For example, power shovels were adapted for use as locomotive cranes, equipment was repaired rather than renewed whenever possible, and on the main dam a fleet of five-ton trucks was pressed into service for extremely heavy duty in the endeavor to complete the dam before the winter snows set in. These trucks brought rock from quarries to the dam in very large pieces; many individual pieces so handled exceeded fifteen tons in weight and the record size piece weighed nineteen tons. These weights are available because all loads were weighed and a record was made of all materials delivered to the dam by the contractor.

Contract for the construction of the project in its entirety is held by the R. C. Storrie Company, through which sub-contracts were let for all materials and equipment needed, as well as for most of the construction

operations. W. A. Brackenridge is consulting engineer for the underwriters and J. D. Galloway is consulting engineer for the Great Western Power Company. Engineering work on the project was done by the Constant Angle Arch Dam Company. Ross White is resident engineer on the development as a whole for the Feather River Company.

The accompanying plan and profile shows the relation of the major features of the work, of which the most spectacular feature—namely, the construction of the high-head penstocks—will be described in detail in a subsequent article. A résumé of statistical information on the major features is appended.

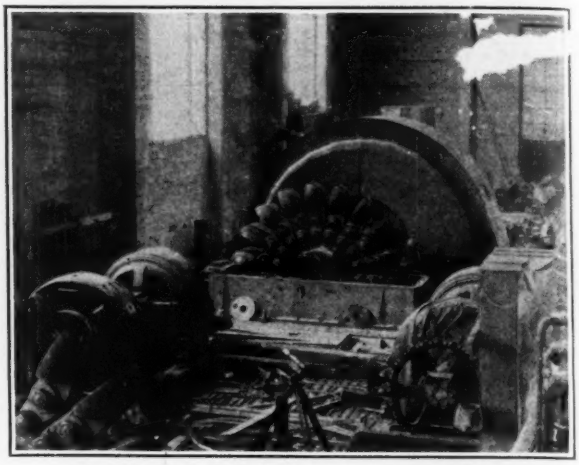
Dams

Bucks Creek Storage Dam—Combination derrick-laid and loose rock fill with concrete gravity retaining wall and cutoff at upstream toe. Upstream face protected by reinforced-concrete slab. Upstream slope, 1.4 to 1; downstream slope, 1.5 to 1. Width of crest, 12 ft. Outlet work consists of two 30-in. needle valves (hand-motor operated) discharged from two 30-in. riveted steel pipes carried through base of dam in reinforced-concrete culvert. Intake to sluice pipes through two 42-in. sluice gates hand operated from reinforced-concrete tower on upstream face of dam containing motor-operated trash racks and rakes. (See Table I.)

Bucks Creek Diversion Dam—Constant-angle arch, 93 ft. high. Contraction joints on approximately 60-ft. centers. Two spillways; one (emergency) over middle crest of dam and the other a concrete-lined channel from one end of dam to a point below downstream toe. Total spillway capacity, 7,700 sec.-ft. Dam has one 24-in. sluice gate, hand operated from emergency spillway bridge, discharging near base. (See Tables I and IV.)

Grizzly Creek Forebay Dam—Constant-angle arch, 98 ft. high. Contraction joints on 65-ft. centers. Spillway 100 ft. long over middle crest of dam, discharging 3,200 sec.-ft. Dam has one 24-in. sluice gate, hand operated from crest of dam, discharging through the dam near the base. (See Tables I and IV.)

Three Lakes Dam—Loose rock fill, 24 ft. high, with compacted earth fill on water side. Water slope riprap protected. Slope of water face, 2½ to 1; slope of downstream face, 1½ to 1; freeboard at maximum high water, 6 ft. Outlet works consist of 20-in. cast-iron pipe through base of dam controlled by 20-in. gate valve in house at toe of dam. Downstream flange of valve connects with short length of pipe, to flange of which disks with varying size orifices may be bolted, thereby relieving the gate valve of throttling service.



ASSEMBLING UNITS IN THE POWER HOUSE
Note the radial lug type of bucket fastening.

Velocity of flow of water through dam along outlet pipe minimized by eight concrete collars, 10 in. wide cast on pipe. (See Table I.)

Tunnels, Conduits and Penstocks

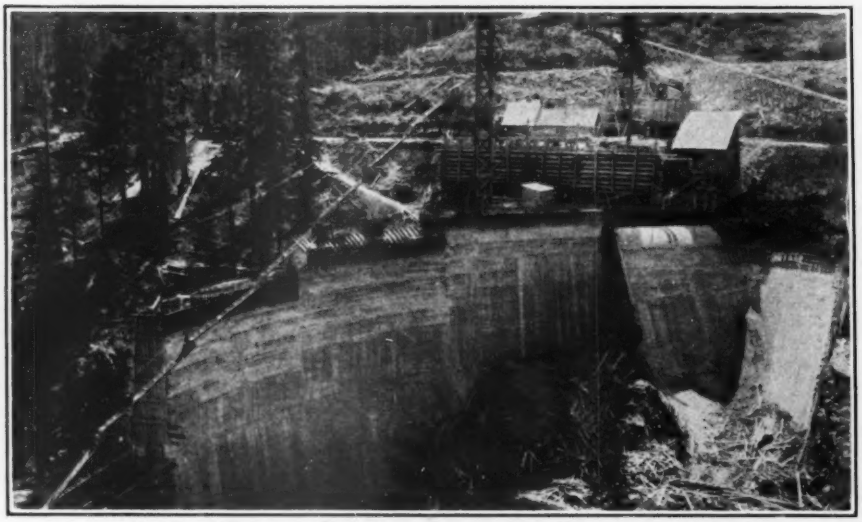
Tunnel No. 1—Pressure tunnel from Grizzly Creek forebay to head of penstocks. Intake structure consists of reinforced-concrete tower with two hand-motor-operated 36x72-in. sluice gates. (See Table IV.)

Tunnel No. 2—From Bucks Creek diversion dam to Grizzly Creek. Intake structure consists of reinforced-concrete tower with hand-motor-operated 5-ft. cylinder gate. Tunnel has free delivery into Grizzly Creek. (See Table IV.)

Surge Chamber—Lower end of tunnel No. 1, where it joins the penstocks, is enlarged [illegible]rm a 17,000-cu.ft. chamber connecting with a surfa[illegible]er and spillway through a shaft 6 ft. 8 in. in dia[illegible] and 100 ft. in depth. Structure concrete lined throughout.

Milk Ranch Conduit—Diverts from Milk Ranch Creek below Three Lakes dam and discharges into Bucks Creek diversion reservoir, 8.05 miles away. Seventeen intermediate diversions are conveyed into the main pipe by twelve 18-in. standpipes extended up the hillside above hydraulic gradient. Vacuum relief valves at approximately 1,000-ft. intervals. Pipe made by the Western Pipe & Steel Company. (See Table III.)

Penstocks—Penstocks are supported on concrete piers above ground all the way from portal of tunnel No. 1 to power house, where each pipe has a Y-branch to wheels. Upper section of the line, which is triple-riveted double-butt strap pipe, was fabricated by the Western Pipe & Steel Company. Lower section of line down to Y-branches at power house is uniformly 36 in. inside diameter, Ferrum, banded pipe. Pipes from Y-branches to wheels are Ferrum, banded, 26-in. inside diameter. Each penstock contains sixteen vertical bends and one alignment bend, concrete, gravity-type anchorages being provided at bends. Expansion joints located below each anchor. Lower portion of line designed for a maximum pressure equivalent to static head; middle and upper portions designed for static head plus water hammer caused by instantaneous gate closure.



BUCKS CREEK DIVERSION DAM UNDER CONSTRUCTION
The construction railroad passes just behind the material bunkers on far side of dam.

Butterfly valve in each pipe at tunnel portal. (See Table V.)

Impulse Turbines—Penstock supply to each 35,000-hp. unit is controlled by a 36-in., high-pressure, cast-steel, hydraulic, cylinder-operated gate valve. A third gate valve is located on a cross-connection between the two penstocks, to make possible the use of both lines in serving low load on one unit, thereby reducing pipe friction losses. Each turbine has a main power nozzle and an auxiliary relief nozzle. Speed controlled automatically by inclosed, oil-pressure, direct-motion governor, actuated by central oil pressure system for both units. Prime movers and control equipment made by the Pelton Water Wheel Company. (See Table VI.)

Generators—Generators are revolving field type, direct connected to hydraulic turbines. Classification: Sixteen pole, 25,000 kva., 20,000 kw., 0.8 power factor, 11,000 volt, three phase, 60 cycle. WR^2=1,380,000 lb./ft.^{2}. Excitation by separate units, driven at 900 r.p.m. by 450-hp. impulse turbine. Ventilation effected through the use of air washers at rear of power house, air passing through generators and out ducts at front of building. Generators made by the General Electric Company.

Transformers—Three outdoor, 8,333-kva., single-phase, 60-cycle, water-cooled, 240/11-kv., Y-connected transformers made by the General Electric Company.

Cranes—Two 50-ton traveling cranes, each having a capacity of 50 tons on the main hoist and ten tons on the auxiliary hoist.

Power House—Reinforced-concrete substructure on rock; structural steel frame; composition roof, steel sash; switchboard, battery room and switch cells on balcony annex. Dimensions: length, 132 ft.; width, 47 ft.; height, 33ft. from operating floor to crane rail.

Miscellaneous

Operators' Quarters—Located half a mile north of power house on opposite side of river; five cottages and operators' clubhouse.

Remote Control—Visual water levels and valve position indication at power house, as well as operation of the valves, is accomplished from power house, by remote control system. At main reservoir ten positions (from closed to open) of the needle valves are effected; likewise ten positions are provided at the cylinder gate controlling intake to tunnel No. 2. Sluice gates at tunnel No. 1 intake have but two remotely operated positions—viz., open and closed. Butterfly valves, similarly, are remotely operated to open or closed position. Electric interlock prevents the opening of butterfly valve until its bypass valve has been opened. Trash racks at the reservoirs, although motor powered, are not remotely operated.

TABLE I—DAMS

Unit	Function	Type	Height (Ft.)	Length (Ft.)	Cubic Ydge. in Dam	Spillway Capacity (Sec. Ft.)	Reservoir Capacity (Acre-Ft.)	Drainage Area (Sq. Mi.)
Three Lakes Dam	Storage for milk ranch conduit	Rockfill	24	530	.....	250	500	1.0
Small Diversion Dams (17)	Feeding milk ranch conduit	Concrete	3 to 5	10 to 30	.....	Varying	Nominal	Varying
Bucks Creek Storage Dam	Main storage works	Rock fill	118	1,220	326,000	7,000	116,000	28.0
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* Including milk ranch conduit drainage area.

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	Main Storage Reservoir	Diversion Reservoir	Forebay Reservoir	Three Lakes Reservoir
Spillway elevation	5,155.0	5,022	4,315	6,071.3
El. top of flashboards	5,162.5	5,029	4,320	.....
Capacity (acre-ft.) at spillway crest	101,926	5,422	1,044	1,000
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Area (acres) at max. capacity	1,977	146.6	40.8	50+

TABLE III—MILK RANCH CONDUIT

(Welded steel pipe, soil-proofed and buried)

Length	8.05 miles
Diameter, upper end	23 in.
Diameter, lower end	36 in.
Maximum head	100 ft.
Capacity, upper end	20 c.f.s.
Capacity, lower end	75 c.f.s.
Hydraulic grade	12 ft. per 1,000 ft.

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Unit	Length (Ft.)	Adits	Cross-section (Sq.Ft.)	Grade (Ft. Per Thousand)	Lining	Max. Head (Ft.)	Max. Capacity (Sec.Ft.)	Intake Control
Tunnel No. 1 (lower tunnel)	*9,500	One	Unlined, 64.0 Lined, 43.0	5.25	838	99	270	Two 36x72-in. sluice gates
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(Two parallel lines, 7 ft. apart on centers)

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Riveted	2,056.1	54	42	1,249.00	¼	11	12.5	120
Banded	2,656.13	36	36	2,561.62	*19/32	*63/64	16.9	†120

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TABLE VI—POWER HOUSE EQUIPMENT

Prime movers	Two double overhung impulse turbines
Capacity, each unit	35,000 hp.
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Transmission voltage	165,000 (present) 220,000 (ultimate)

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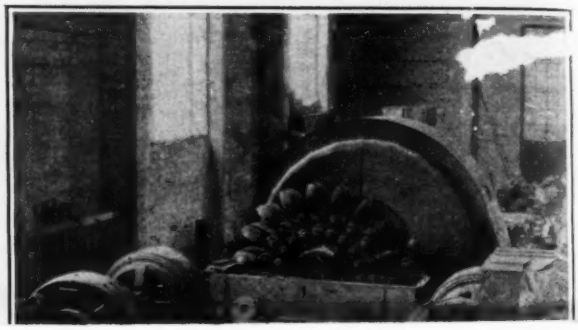

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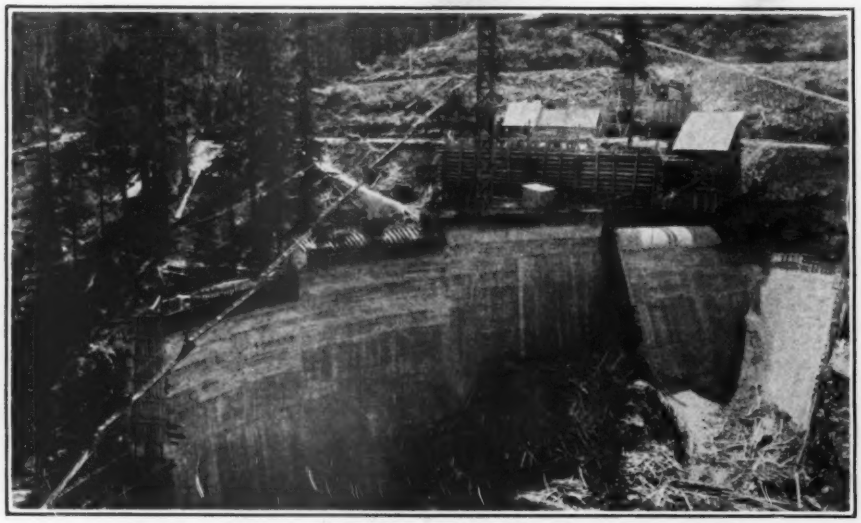

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The construction railroad passes just behind the material bunkers on far side of dam.

Butterfly valve in each pipe at tunnel portal. (See Table V.)

Impulse Turbines—Penstock supply to each 35,000-hp. unit is controlled by a 36-in., high-pressure, cast-steel, hydraulic, cylinder-operated gate valve. A third gate valve is located on a cross-connection between the two penstocks, to make possible the use of both lines in serving low load on one unit, thereby reducing pipe friction losses. Each turbine has a main power nozzle and an auxiliary relief nozzle. Speed controlled automatically by inclosed, oil-pressure, direct-motion governor, actuated by central oil pressure system for both units. Prime movers and control equipment made by the Pelton Water Wheel Company. (See Table VI.)

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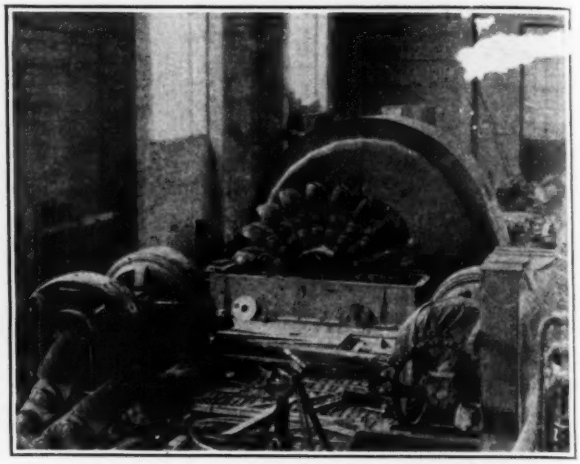

ASSEMBLING UNITS IN THE POWER HOUSE
Note the radial lug type of bucket fastening.

Velocity of flow of water through dam along outlet pipe minimized by eight concrete collars, 10 in. wide cast on pipe. (See Table I.)

Tunnels, Conduits and Penstocks

Tunnel No. 1—Pressure tunnel from Grizzly Creek forebay to head of penstocks. Intake structure consists of reinforced-concrete tower with two hand-motor-operated 36x72-in. sluice gates. (See Table IV.)

Tunnel No. 2—From Bucks Creek diversion dam to Grizzly Creek. Intake structure consists of reinforced-concrete tower with hand-motor-operated 5-ft. cylinder gate. Tunnel has free delivery into Grizzly Creek. (See Table IV.)

Surge Chamber—Lower end of tunnel No. 1, where it joins the penstocks, is enlarged to form a 17,000-cu.ft. chamber connecting with a surface reservoir and spillway through a shaft 6 ft. 8 in. in diameter and 100 ft. in depth. Structure concrete lined throughout.

Milk Ranch Conduit—Diverts from Milk Ranch Creek below Three Lakes dam and discharges into Bucks Creek diversion reservoir, 8.05 miles away. Seventeen intermediate diversions are conveyed into the main pipe by twelve 18-in. standpipes extended up the hillside above hydraulic gradient. Vacuum relief valves at approximately 1,000-ft. intervals. Pipe made by the Western Pipe & Steel Company. (See Table III.)

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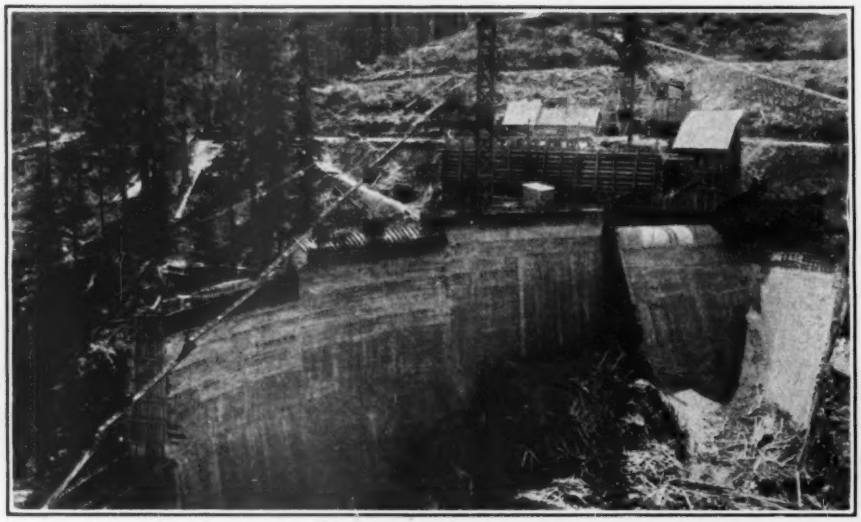

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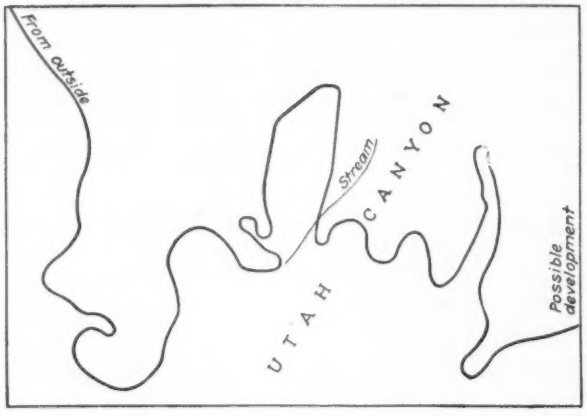
Oil Field Problems and Practices in Road Building

Demand for Good Roads Greatest During Oil Rush but Time Too Valuable Then for Road Work—Some Notable Exceptions

By A. H. Riney
Chief Engineer, Phillips Petroleum Company,
Bartlesville, Okla.

As a general rule oil field roads, during infancy, exist by circumstances; during middle life, by reasonable care, and during old age, by virtue of past attention. During the initial boom period of a field, when dependable traffic routes are most needed, roads always seem to be at their worst. By the time the big rush is over and



ACROSS-CANYON HIGHWAY BUILT TO DRILL WILDCAT (TRIAL) WELL

activity has settled down for the long period of steady operation, highways have been or are being improved for the light traffic which alone remains to use them. When the end of the field approaches, roads that have been constructed usually are thrown upon their own resources to remain intact until the end.

Those who have been through the experience of a big oil field boom can readily understand why road building receives so little attention at the time roads are most needed. Gold is gold, and so is oil and, once discovered, neither can be left unappropriated. A rush begins almost overnight. To get there with materials is the main urge, and oil fields always demand great quantities of things at the start.

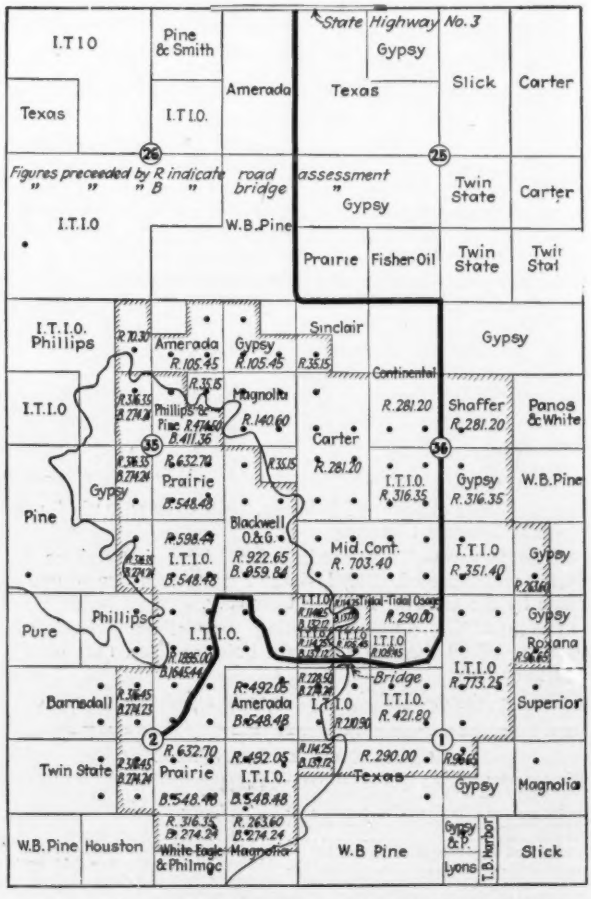
What individual under these boom circumstances will sacrifice valuable time to build a better road so long as he can manage to move his own materials in some manner or other over the existing roads? Not so much is it the money cost involved as it is the valuable time required. Most probably the oil company has thrown the burden of material movement onto the shoulders of a hauling contractor, thus minimizing its own direct interest in the condition of the highway. This being the case, the hauling contractor will not unhitch his revenue-earning teams or postpone loading his money-making trucks just to apply them to the good task of constructing a road that someone else is to destroy shortly afterward. Let us always bear in mind that oil fields have the habit of occurring in sparsely settled communities, where the local or county governments cannot immediately assume all of the responsibilities so suddenly thrust upon them.

Exceptions to the Rule—In spite of these dreary pictures of the typical oil field road condition, there exist certain outstanding exceptions to the rule. A few oil fields are favored with the presence of operators who take the situation into their own hands or perhaps enlist the aid of other progressive operators, and set to work building roads right at the beginning of development.

An outstanding illustration of co-operation along these lines is that of recent date wherein the Indian Territory Illuminating Oil Company, a large operator in the world-famous Seminole oil field of Oklahoma, assumed the initiative in constructing a road system to serve the booming Little River Pool of that district. The point of interest in this case is not the details of construction so much as it is the use of systematic methods for promoting and completing the development of the road system, a procedure unique in oil field experience.

For several days actual census data were collected to determine the number of vehicles that were making the brave attempts to travel over the existing byways leading to the Little River Pool operations. One typical day's traffic summary was as follows: Automobiles, 1,591; light auto trucks, 180; heavy auto trucks, 180; trams, 62; heavy hauling tractors with trailers, 5, and equestrians, 21.

The accompanying map shows that the route selected leaves the Oklahoma state highway route No. 3 on a southerly course, and after progressing some distance into the pool proper, crosses the stream known as Little River and continues thence to the border of present



ASSESSMENT DISTRICTION PLAN FOR OKLAHOMA OIL FIELD ROAD

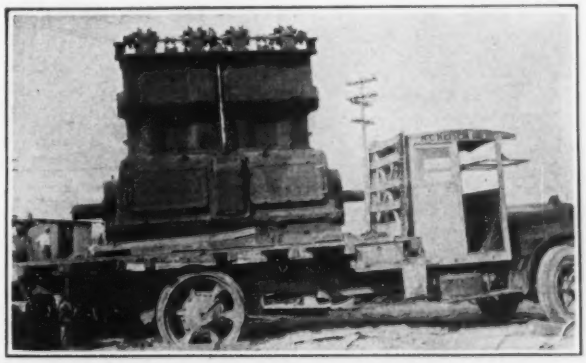
A TEAM LOAD FOR AN OIL FIELD ROAD
Only on well-kept roads can such loads as this be transported. Much of the oil field hauling is of very heavy equipment. This is an exceptional oil field road.

drilling limits, which is its terminus until additional drilling pushes the border line farther out into undeveloped territory. The construction specifications for this road called for earth grading only, except for several stretches that required the addition of rock surfacing to bear heavy loads over soft spots. Its total cost was approximately $15,000 plus a bridge expenditure of $8,000, making a total of $23,000.

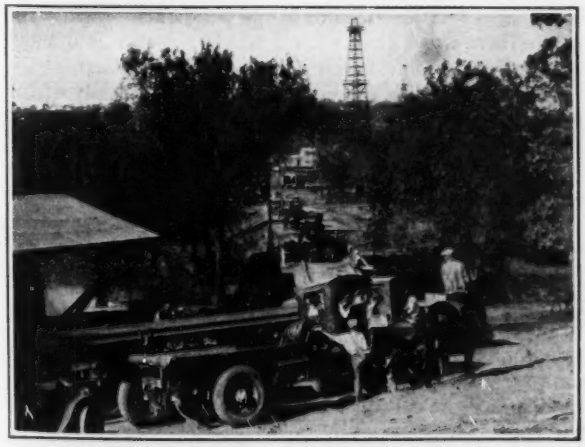
Cost Assessment Plan—The basis of cost assessment was according to the amount of acreage served, and these assessments were adjusted in accordance with the length of the road traveled in reaching the assessed property. Only those leases to reach which required crossing the bridge were assessed for the cost of the bridge. The map shows these amounts as assessed against each lease, the prefix *R* before each figure indicating road assessment and the prefix *B* indicating bridge assessment. The shaded outlines indicate the territory bearing road assessment and bridge assessment. The oil operators served realize that their share of the cost is a very good investment and are gladly paying. This systematic oil field road-building job was promoted through the efforts of M. J. Kirwan, general manager, and S. M. Gilkey, assistant manager of the production division of the I.T.I.O. company.

Texas Panhandle Case—The Panhandle field of Texas also offers us some good examples of progressive oil field road construction. At the time of the boom development no railroad existed closer than 30 miles from the field. All transportation from railroad was by auto trucks, of which there were many hundreds, and practically all of them were of great hauling capacity. Day and night they rushed back and forth between the railroad town of Panhandle and the field in an almost futile attempt to relieve the never-ending influx of freight shipments. At times freight receipts compared on equal or greater tonnage bases with those of many of the largest freight terminals of the Santa Fe railroad.

The cry for more materials in the field accelerated the efforts of the truckers. Many times the 30-mile stretch of dirt road—yes, often, mud road—was practically



A TRUCK LOAD FOR AN OIL FIELD ROAD
Oil field trucking contractors, being paid on tonnage basis, often overload their trucks. This makes the necessity for passable roads even more important. Here is a 15-ton engine to be used in generating electricity at a gasoline plant, being hauled on the bed of a 5-ton truck.



TRAFFIC JAM AT A BRIDGE
This is a bridge on the road built by the assessment plan illustrated and described.

traffic bound. When impassable places were approached, the trucks would travel across open prairie or use any other method that might make it possible to reach the destination. Before the matter of highway construction could be handled by the county government through a bond election a branch line of the railroad was rushed through to the field. Now, after the big demand is over, a permanent concrete highway is in process of construction, all of the grading having been completed and the concrete culverts constructed.

The topography of the Panhandle field proper is very rough and is cut through by the Canadian River and its numerous tributaries, all of which have formed wide canyons 250 to 300 ft. deep. A producing field

exists on both sides of the river, but in the early days of the field (1926) in order to get to an opposite side one had to drive 75 miles or more by way of the nearest bridge. In the beginning the county entered into agreement with the bridge company for the construction of a 2,500-ft. steel highway toll bridge, supported by steel-pipe concrete-filled piles. As an illustration of the uncertainty of initial oil field highway location, let it be known that although this steel bridge was located where it was thought the trend of the field was progressing so as to make this the logical crossing for a main highway, before construction was half over developments proved that the field would extend in an entirely different direction. Accordingly this highway route was abandoned, and the bridge, although completed for more than a year, has been used only slightly. Now a second similar bridge is under construction at a point 5 miles upstream on the finally adopted main highway crossing. In addition to these two bridges, a third of wood-piling construction built by the Rock Island railroad several miles still farther upstream is used also as a vehicle crossing.

The construction of the main highway through the field has been difficult, first, on account of the very rough topography, and second, on account of the great amount of oil field equipment and pipe lines to be moved. Whereas operators during boom days were satisfied to have roadways into and out of canyons having grades as high as 12 and 14 per cent, deep cuts through ridges and long side-hill cuts now have been made to carry the new concrete highway on grades practically as easy as those employed in normal highway construction.

UTAH CANYON CROSSED BY OIL FIELD ROAD

A typical view of a 700-ft. deep canyon in Utah which serves as a barrier to the hauling of materials for a wildcat well on 100,000 acres of leased land and across which a roadway is now being constructed by a Mid-Continent oil company.

TRAFFIC JAM ON MAIN ST., BORGER, TEX.

Road conditions even in streets of oil field boom towns during the rush period usually are very bad, as is shown in this illustration—the main street of Borger, Tex., during the early days.

This highway is approximately 15 miles long, and practically all of it threads its way among the irregularly assembled oil derricks, storage tanks, gasoline plants and oil field equipment. It connects Borger, the largest town of Hutchinson County, with Stinnet, the county seat. The crossing over the Canadian River is approximately midway, and is constructed entirely on a quicksand river bed.

A Utah Problem—What any engineer would term a unique roadbuilding job but one that is typical of the kind often confronting the oil production man in his exploration of new territory in quest of oil was recently attempted in Utah. A Mid-Continent oil company is undertaking to test the oil possibilities of a geological structure outlined over an area of more than 100,000 acres of lease. To reach this location with materials for drilling the wildcat test well, it is necessary first to travel over 50 miles of sandy hilly trail from the nearest railroad. This part of the route, however, does not cause so much concern when one learns that almost in sight of the destination there is a canyon barrier about 700 ft. deep, to detour which would require 50 miles travel and the breaking of a trail.

Due to the extreme width and irregularity of the canyon cross-section, all original hopes for the construction of an aërial cableway, suspension bridge, incline railway track or other structural device were abandoned on the first investigation of the exploration party organized to investigate the bottom of the canyon. Nature, however, proved good enough to supply one particular point in 15 miles of almost perpendicular rock walls where there was a chance for a winding roadway into and out of the canyon. It has been decided to undertake the construction of this roadway for the delivery only of the materials for this single wildcat well, a quantity of approximately 500 tons.

Specifications call for a one-way roadway 14 ft. in width with a maximum grade of 12 per cent and curves of not less than 45 ft. radius. Its total length is 5.7 miles, the rough canyon portion being more than 12,000 ft. through solid red sandstone, except for a portion near the bottom, which is in loose disintegrated sand rock. Practically all of the roadway necessitates blasting out the side hill, using black powder. Due to the fact that a man can proceed over the route only with the aid of ropes and rope ladders at certain points, work must progress from one end only.

The cost will be many thousand dollars, and the chances are all in favor of these efforts being in vain, for the "batting average" of wildcat wells is very low indeed.

Ferric Salts as Coagulants for Activated Sludge Prior to Filtration

Studies by the Sanitary District of Chicago Show That a New Coagulant, Chlorinated Copperas, Is Better Than Anything Before Tried

By F. W. Mohlman and J. R. Palmer
Chief Chemist and Principal Assistant Chemist, Sanitary District of Chicago

IN THE development of the activated-sludge process of sewage treatment during the past ten years the dewatering of excess activated sludge has been one of the most troublesome problems. The desirability and at times necessity of an efficient coagulant prior to filtration has been recognized since the first experiments on the recovery of the sludge for fertilizer.

Research at the Calumet sewage-works of the Sanitary District of Chicago has resulted in the discovery and development of a new coagulant, chlorinated copperas (ferrous sulphate), which has proved to be more effective than any chemical used heretofore for the coagulation of activated sludge.

In 1923 it had been concluded as a result of experimental work that filter alum (aluminum sulphate) was the most satisfactory coagulant. Many coagulants had been tested in these experiments, including sulphuric acid, heat, alum, dicalcium phosphate, bone ash, sulphur dioxide and filter-cel. The tests were made both on a laboratory scale and on a working scale, the latter with a plate-and-frame filter press, an American vacuum filter and a large Oliver vacuum filter. Since April, 1923, the activated sludge produced at the Calumet sewage-works has been filtered on an Oliver filter 11.2 ft. in diameter and 14 ft. long, with a filter area of 495 sq.ft. The sludge supplied to the filter has varied between 96 and 97.5 per cent moisture, averaging 97 in 1924 and 96.9 in 1925 and 1926. In general, alum has been applied in proportion to the concentration of solids in the sludge, although other factors, such as speed of the drum, age and type of filter cloth and seasonal variations also influence the amount added.

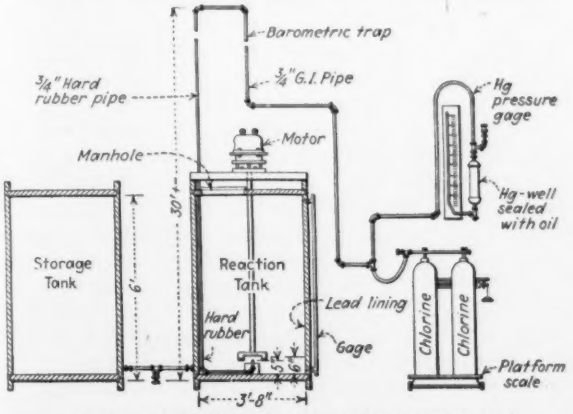


FIG. 1—APPARATUS FOR PRODUCTION OF CHLORINATED COPPERAS

In November, 1924, an industrial waste from a paint factory, containing sulphites, spent acids, oils and metallic pigments, was introduced into the sewage treated at the plant. These wastes proved to be very germicidal. They were discharged intermittently, causing wide ranges in the bacterial count, hydrogen-ion concentration and dissolved oxygen of the plant influent. These conditions seriously affected the activated-sludge process. The filtration of the sludge became much more difficult. When using the same amounts of alum previously used in 1924 (7 to 11 lb. per 1,000 gal.) it became impossible to produce a satisfactory cake from the Oliver filter. Accordingly, in 1925 the amount of alum was greatly increased, in fact nearly doubled, averaging 17 lb. per 1,000 gal., as compared with 9.7 lb. in 1924. The increased difficulty and expense of filtration served as an incentive to search for more efficient coagulants. Many laboratory filtration tests were made in March and April, 1925, using 250 c.c. of conditioned sludge upon No. 1 Whatman filter papers in 9-cm.-diameter Buchner funnels.

Discovery of Value of Iron Salts—The discovery was made (J. R. Palmer) that ferric salts, particularly ferric chloride, greatly facilitated filtrations. Even the preliminary qualitative tests were sufficient to show the remarkable coagulative power of ferric chloride. The treated activated sludge is coagulated in large, tough flocs, easily visible in a glass cylinder. The difference in size of these flocs and those precipitated with alum was very perceptible. Comparative filtration tests also indicated that ferric salts were decidedly superior to analogous aluminum salts. The results of these tests are shown in Table I, based on the use of equal weights of all salts. However, this does not indicate the relative value of an equivalent weight of iron or aluminum as chloride, sulphate or nitrate. Later tests indicated that with an equivalent weight of iron or aluminum the chlorides filtered most rapidly, while the nitrates came next and the sulphates were slowest in filtration. In all instances the ferric salts were superior to the corresponding aluminum salts, while the best results obtained with any of the aluminum salts, namely the chloride, were but slightly better than the poorest of the ferric salts, ferric sulphate.

Inasmuch as ferric chloride seemed most promising, a number of filtration tests were made in the laboratory on Buchner funnels, comparing varying amounts of aluminum sulphate with ferric chloride. The results of these tests indicated that as little as 5 lb. of ferric chloride per 1,000 gal. of sludge was superior to 15 lb. of alum. These tests were made with a sludge of poor quality. When the sludge improved, somewhat later in the summer, there was still a decided advantage in the use of ferric chloride, as compared with alum, although the difference was not as marked as when the sludge was in poorer condition. Apparently the conditioning effect obtained with alum is affected more by the condition of the sludge than is the case with ferric chloride. Where the latter showed an improvement over alum with a fairly good sludge it showed a much greater improvement with poor sludge.

Composition and Cost of Iron Salts—Experiments on a larger scale required the purchase of commercial ferric chloride, but we found that this salt was not produced on a large scale, and that the minimum price was 6c. per lb., f.o.b. Chicago, compared with 1.5c. per lb. for alum. Ferric chloride is very corrosive and difficult to store, and although a number of chemical manufacturers expressed interest in its manufacture, none offered any price inducement that would enable it to compete with alum. An emergency might justify the high cost of ferric chloride but not ordinary conditions of filtration.

TABLE I—COMPARISON OF EQUAL WEIGHTS OF IRON AND ALUMINUM SALTS

April 11, 1925

Weight of Conditioner per 1,000 Gal. Sludge	Time to Filter 200 c.c. Filtrate Min.	Sec.	Total Time of Filtration Min.	Sec.
10 lb. aluminum sulphate $Al_2(SO_4)_3.18H_2O$	4	35	9	18
10 lb. aluminum nitrate $Al(NO_3)_3.9H_2O$	4	00	7	37
10 lb. aluminum chloride $AlCl_3.6H_2O$	2	10	3	40
10 lb. ferric sulphate $Fe_2(SO_4)_3$	2	15	3	53
10 lb. ferric nitrate $Fe(NO_3)_3.9H_2O$	1	52	3	00
10 lb. ferric chloride $FeCl_3.6H_2O$	1	42	2	18
Specific gravity of sludge			1.014	
Maximum vacuum			18 in.	

Further tests were therefore made to compare other ferric salts with the chloride, and to consider ways in which such coagulants might be made and used. Since the coagulant must be dissolved before being used, it can be made in the form of a solution, obviating crystallization, drying and shipment. The following sources of ferric salts were investigated:

Ferric Chloride: (1) Dissolving scrap iron in hydrochloric acid and oxidizing with chlorine; (2) dissolving iron ore in hydrochloric acid; (3) bubbling liquid chlorine through water trickling over scrap iron.

Mixture of Ferric Chlorine and Ferric Sulphate: (4) Oxidizing ferrous sulphate (copperas) with (*a*) air, (*b*) sodium nitrate and sulphuric acid, (*c*) chlorine; (5) dissolving iron ore and salt (NaCl) in sulphuric acid.

All of these processes for producing ferric salts were tested, but were finally abandoned in favor of oxidation of copperas by chlorine. This procedure gives a mixture of 71 per cent ferric sulphate and 29 per cent anhydrous ferric chloride.

$$6FeSO_4 + 3Cl_2 = 2Fe_2(SO_4)_3 + 2FeCl_3.$$

The chlorine required is theoretically one-eighth of the weight of the copperas:

$$Cl_2 : 2FeSO_4.7H_2O = \underset{\text{Weights}}{\overset{\text{Molecular}}{71:556}} = 1:7.8$$

This method of producing ferric salts has been known for a long time, and in fact was mentioned in the 1890 Report of the State Board of Health of Massachusetts by Hiram F. Mills, in connection with the use of ferric salts as precipitants for sewage, at the time when chemical precipitation was in vogue. In the section on Water Supply and Sewage, p. 738, he says: "A ferric salt can be made by oxidizing copperas with chlorine or with sulphuric acid and nitrate of soda."

Production of Chlorinated Copperas—In the fall of 1925, a small plant was constructed for the production of chlorinated copperas. With the assistance of the Wallace & Tiernan Company and the co-operation of Linn Enslow of the Chlorine Institute, apparatus was designed to chlorinate a charge of 1,400 lb. of copperas.

The equipment (Fig. 1) consists of a 44x72-in. lead-lined tank, on top of which is mounted a vertical motor connected to a rubber-covered steel shaft, on the lower end of which is a special vulcanite turbine. This turbine operates at 1,800 r.p.m., and aids in dissolving the copperas as well as in diffusing the chlorine. The chlorine gas is passed through a ¾-in. line directly under the turbine and is discharged through peripheral holes in the flange of the turbine disk. The absorption of gas is quite rapid, due to its highly diffused condition. Tests are made at intervals with potassium permanganate to determine the degree of oxidation. It is possible to reach 98 to 99 per cent oxidation without appreciable loss of chlorine, at a rate of absorption of approximately 15 lb. per hour from two cylinders.

Filtration Tests with Ferric Salts—Filtration tests with ferric salts have been made as follows: Laboratory tests: (1) Buchner funnels, filter paper; (2) filter leaf, covered with canvas. Small-scale tests: (1) American vacuum filter, 1.8 sq.ft. cloth area. Plant-scale tests: (1) Oliver vacuum filter, 495 sq.ft. cloth area.

The first tests, described previously, were made on Buchner funnels, using filter paper. Further tests were made with a small filter leaf covered with the same material as used on the Oliver filter. This was a rectangular leaf with about ½-sq.ft. filter area connected with pressure tubing to a graduated cylinder large enough to receive the filtrate. This graduate, in turn, was connected to the vacuum line. The leaf was immersed in the conditioned sludge after the vacuum had been applied, and kept submerged during a pick-up time corresponding to the pick-up on the Oliver filter at the time of the tests. It was then instantly removed and allowed to drain with the vacuum still on for a period corresponding to the drying time on the filter. In this manner it was possible to determine filtrability of a sludge as indicated by the volume of filtrate passed through in a given time. A number of tests of this nature were made on activated sludge from both the Calumet and the Des Plaines River sewage-works. The results obtained by this method are shown by the curves in Figs. 2, 3 and 4, using aluminum sul-

TABLE II—COMPARATIVE RUNS ON OLIVER FILTER AT CALUMET WITH ALUM AND IRON SALTS

Date	Filter Feed Gal.	Lb. Conditioner per 1,000 Gal.	Cake Removed Lb.	Length of Run Hr.	Filter Feed Gal. per Hour	Gravity	Moisture	Cake Moisture	Yield Dry Solids Lb./Sq.Ft./Min. 10 Per Cent Basis	Speed of Drum, Min.
4/22/25	5,000	15 Alum	1,973	3.53	1,410	1.014	.....	78.32	0.005	11
4/23/25	3,000	15 Ferric chloride	2,276	1.17	2,560	.....	96.94	79.48	0.015	11
4/23/25	3,000	20 Ferric chloride	2,480	0.82	3,360	.....	96.60	79.93	0.023	11
9/ 4/25	2,800	20 Alum	2,877	0.47	5,950	1.016	97.0	81.3	0.042	3½
9/ 4/25	1,400	20 Copperas chlorinated	1,525	0.13	.....	.016	97.0	81.5	0.081	3½
12/22/25	4,000	25 Alum	3,995	1.17	3,420	.011	97.6	81.1	0.023	3½
12/22/25	4,000	16 Ferric chloride	5,276	0.91	4,400	.010	97.6	81.1	0.041	3½
1/26/26	3,900	14 Alum	4,345	1.00	3,900	1.012	97.1	82.3	0.028	3½
1/26/26	3,900	14 Ferric chloride	4,883	0.75	5,200	1.012	97.1	80.8	0.046	3½
2/25/26	3,400	20 Alum	3,725	1.25	2,730	1.012	96.7	78.9	0.017	3½
2/25/26	3,400	20 Ferric chloride	5,025	1.08	3,160	1.015	97.2	78.9	0.036	3½
6/18/26	4,000	18 Alum	4,782	2.05	1,950	1.019	96.1	76.6	0.020	5½
6/18/26	4,200	18 Ferric chloride	5,755	1.42	2,960	1.020	95.7	76.5	0.032	5½
11/16/26	6,500	15 Alum	4,530	1.42	4,560	1.012	97.0	81.3	0.022	3½
11/16/26	6,700	15 Copperas chlorinated	2,280	0.33	20,300	1.012	97.0	81.7	0.047	3½

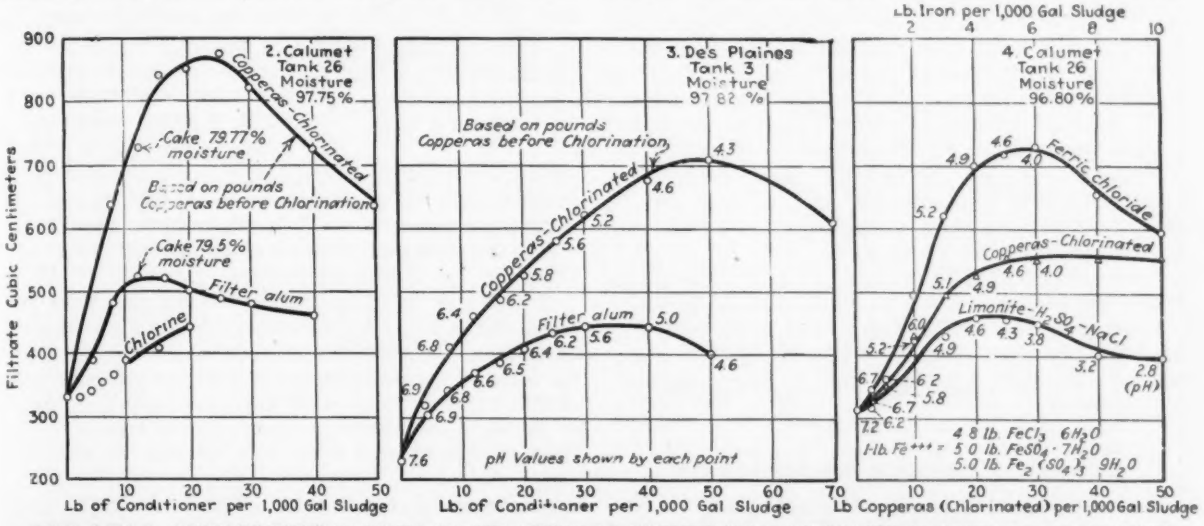
phate, chlorinated copperas and chlorine for conditioning agents.

In Fig. 2 chlorinated copperas is compared with alum, using Calumet sludge. The optimum amount of ferric salt is about 24 lb. per 1,000 gal. as compared with 14 lb. for alum, but the rates of filtration are far greater with iron even when using the same weight as alum. The effect of chlorine alone is also shown in Fig. 2. An unsuccessful attempt was made to form ferric chloride from the iron present in the sludge, merely by applying chlorine. Apparently chlorine alone has little coagulating power.

The results of similar tests on activated sludge from the Des Plaines River sewage-works are shown in Fig. 3. This sludge had almost exactly the same moisture content as the Calumet sludge (97.82 Des Plaines and 97.75 Calumet) and yet the optimum dosage for Des Plaines Calumet sludge, the optimum amount of ferric chloride was approximately 30 lb. per 1,000 gal., as compared with 24 lb. chlorinated copperas in Fig. 2. The increase is probably due to the use of 96.80 per cent sludge in Fig. 4 as compared with 97.75 per cent used in Fig. 2.

American and Oliver Filters—Tests were made at the Calumet works in June, 1925, with a small American filter, in co-operation with J. L. Mennell, representative of the United Filters Corporation. These tests indicated marked superiority of ferric chloride as compared with alum. Additional tests were later made at Houston, Texas, by Mr. Mennell, who has developed a control apparatus for adjusting the feed of coagulant.

Test runs were made regularly during 1925 and 1926 on the Oliver filter at the Calumet plant, using ferric chloride and chlorinated copperas for conditioning the sludge. These tests were run in parallel with an alum



FIGS. 2 TO 4—RESULTS WITH VARIOUS COAGULATIONS IN CONDITIONING ACTIVATED SLUDGE FOR FILTRATION

Fig. 2—Calumet Plant, 2/14/26. Tank 26. Moisture, 97.75 per cent. Using copperas, filter alum and chlorine.

Fig. 3—Des Plaines Plant, 2/16/26. Tank 3. Moisture, 97.82 per cent. Chlorinated copperas and filter alum.

Fig. 4—Calumet Plant, 7/16/26. Tank 26. Ferric chloride, chlorinated copperas, and ferric sulphate plus salt.

sludge was 58 lb. chlorinated copperas and 30 lb. alum, double the optimum required for Calumet sludge. This difference is probably caused by variations in alkalinity of sewage and percentage of organic matter in the sludge at the two plants, as shown below:

	Alkalinity of Sewage	Organic Matter in Dry Sludge Volatile, Per Cent	Fixed, Per Cent
Des Plaines works	400	65	35
Calumet works	190	55	45

The absorption of coagulant is greater with the Des Plaines sludge because of the higher alkalinity and proportion of organic matter. Hydrogen-ion determinations (pH) indicated that the optimum with iron salts is 4.3, consequently we tried to reduce the amount necessary with Des Plaines sludge to that required by Calumet sludge, first reducing the alkalinity by adding acid. This did not help much, for apparently the coagulation is primarily dependent upon the amount of iron added and the nature of the anion in combination with the ferric ion.

This point is illustrated in Fig. 4. In these tests three ferric salts were used, and although the optimum pH was in all cases about 4.3 yet the pure ferric chloride was decidedly superior to the mixed salts. The repressive effect of the sulphate ion is shown. In these tests, on run on the same day. The results of a number of these runs are shown in Table II. The yield was increased with the use of the iron salts in all cases, varying from 60 to over 100 per cent improvement. With both alum and iron salts the moisture in the cake was practically the same. The average yield during 1926 for all iron runs was 0.032 lb. per sq.ft. per min., corrected to 10 per cent moisture, as compared with a corresponding yield of 0.020 lb. with alum.

Tests at Other Places—Laboratory experiments made by Dallyn and Delaporte on the coagulation of activated sludge from Canadian plants (*Canadian Engineer*, Feb. 9, 1926) indicated that ferric chloride was the most effective coagulant, proving superior to all others except in one test (Kitchener sludge), in which aluminum chloride was best.

Ferric chloride was used in a test on coagulation of activated sludge applied to the Oliver filters at Pasadena, Calif., in May, 1925. The same effective coagulation was noted as has been obtained in Chicago.

Tests have been made by Ardern at Manchester, England, on an Oliver filter, using activated sludge from the Dayyhulme plant (Annual Report Manchester Rivers Department for Year Ending March 31, 1926, p. 30). The tests with ferric chloride, which were run Jan. 13, 1926, indicated that higher yields could be obtained with

ferric chloride than with alum. Comparing the ferric chloride run of this date with an alum run of the preceding day, the yield was 38.5 lb. of dry sludge per hour with ferric chloride as compared with 29.5 lb. with alum. The amounts of coagulants used are not stated, but the records indicate that when an "excess" of ferric chloride was used on Jan. 13, a yield of 45 lb. per hour was obtained, 53 per cent in excess of the alum yield.

Chlorinated copperas has been produced and used for the past several months at the Milwaukee activated-sludge plant. It has been of value in the coagulation of the sludge at a time when all other coagulants appear to have been either ineffective or impractical. The results of these tests will no doubt be available in the near future.

The foregoing results, obtained under such a variety of conditions and at so many activated-sludge plants, indicate that ferric salts are superior to all other coagulants for treatment of activated sludge before filtration.

It is our hope that ferric salts may be produced more cheaply in the near future, in order to make their use economical. The larger projects of the Sanitary District of Chicago will not at once require filtration of activated sludge, inasmuch as the sludge is to be dewatered by digestion with Imhoff sludge and drying on sand beds, but for plants where it is necessary to press and dry the sludge, as at Milwaukee and Pasadena, the use of ferric salts may be of considerable value.

The work described herein was done in the laboratories and at the treatment works of the Sanitary District of Chicago, which are operated under the direction of Edward J. Kelly, chief engineer; Philip Harrington, assistant chief engineer; Langdon Pearse, sanitary engineer; and the writers.

Ice and Leakage Troubles on Water Supply Pipe Lines

Anchor Ice Closes Crib on Intake Pipe in Lake Michigan—Cracks in Submerged Force Main Cause Great Leakage

WATER supply from Lake Michigan for the city of Michigan City, Ind., is furnished by two intake cribs and pipe lines. A 24-in. intake pipe extends from a crib 2,750 ft. out in the lake to a well at the pumping station. A 42-in. cast-iron intake pipe extends from another crib 3,000 ft. out to a shore well, whence a 30-in. pipe leads to another well at the pumping station. A line of 48-in. reinforced-concrete pipe has been built from this station to the shore well to supplement the 30-in. pipe, and at some future time a 48-in. intake pipe will be laid thence to a new crib. In laying the concrete pipe, quicksand was encountered. The trench was kept dry by means of well points and diaphragm pumps.

The 42-in. intake terminates in an upward elbow inside a protecting crib. On a Sunday in January, 1927, the water supply was suddenly shut off at 5 p.m., and it was assumed that the elbow had been washed away and sand piled over the end of the pipe. With great difficulty, on account of ice 20-in. thick, a tug got out to the intake with a diver. He found that the openings in the crib were closed with ice but that the elbow was intact. Over it was a timber screen about 30 ft. below the surface. This screen was of 2 x 8-in. planks forming 4-in. openings, but it had been closed solid with ice, as well as the crib openings.

For about two weeks the weather had been comparatively mild, with the lake water at about 50 deg. F. On the previous Wednesday the temperature dropped to about —10 deg. F., while a high wind made the water so rough that it could not freeze bodily. It was the opinion of W. W. Swasick, city engineer, that the colder surface water then gradually descended, carrying particles of anchor ice in suspension, these particles then adhering to the timber screen and the sides of the pipe opening, gradually building up until the entire screen was covered and eventually the ice was built up to the surface of the water.

FIG. 1—BROKEN PIPE IN FORCE MAIN

Broken Force Main—From the pumping station at the end of the intake, the water is carried across the harbor to the city by two pipe lines 24 in. and 30 in. in diameter. The latter is of cast-iron, in 12-ft. lengths, with bolted flange joints and a flexible joint at every 60 ft. Shortly after the ice troubles on the intake there was a great increase in the pumpage, from a normal 5 m.g.d. to about 7 m.g.d. or more. Industries, mains and hydrants were checked, but no reason was found for this increased pumpage.

An attempt was then made to locate the 30-in. line across the harbor. A man sounded with a 2 x 2-in. pole, 18 ft. long, and although the main was below his reach, the force of the water escaping from the leak was sufficient to twist the pole out of his hands. No disturbance or undue discoloration appeared at the surface. Mr. Swasick then ordered other men to prod the mud and locate the pipe. Soon the water began to boil up to about a foot above the normal surface and over a diameter of about 10 ft., although the pipe was 25 ft. below the surface. A diver reported a broken joint about 20 ft. from the nearest swivel joint, 15 ft. from shore.

FIG. 2—PIPE ERODED BY LEAK AT FLANGE

A pile runway was built for an excavator and the pipe was uncovered for inspection by the diver, as a result of which a 12-ft. length of 30-in. pipe and a sleeve joint were ordered. When the broken pipe was hoisted out, Fig. 1, it was found that it had cracked around the flange, probably when it was laid fourteen years ago. Constant erosion had widened the crack and even the heads of the 1½-in. flange bolts had been worn away (see Fig. 2). After the new length had been installed, another leak was found 30 ft. farther out, a crack ⅛ to ¼ in. wide running the entire length of one pipe. Repairs were made in the same way, but in connection with other improvements it is proposed to build a concrete tunnel under the harbor to carry the water pipe and an inverted siphon for an outfall sewer.

These occurrences were described by Charles Brossmann, Indianapolis, Ind., at a meeting of the Indiana section of the American Water Works Association. The water supply and sewerage improvements are being planned under the direction of Wade W. Swasick, city engineer, and Mr. Brossmann, consulting engineer for the city.

Track With Concrete Base Gives Successful Results

Experience on Pere Marquette Railroad Indicates Saving in Maintenance and Suggests Certain Improvements

THAT railway track with a rigid foundation will be a good-riding track if the rails are anchored rigidly to the foundation is a principle that is considered proved by twelve months' experience with the experimental reinforced-concrete roadbed of the Pere Marquette Railroad, as described in *Engineering News-Record* of Feb. 24, 1927, p. 312, and Dec. 10, 1925, p. 958. This important conclusion was stated in a paper read before the Maintenance of Way Club of Chicago by Paul Chipman, office engineer of the Pere Marquette Railroad. The main points of this paper are summarized herewith.

In preparing the design, study of earlier experiments showed unanimous opinion that there must be a cushion of some resilient material between the rail and the concrete to lessen shocks and prevent deterioration of concrete, battering of rails and injury to rolling stock. However, troubles in former experiments, notably those of the Northern Pacific Railway, were not in the concrete, but in the blocking that separated the rails from the foundation. It seems to have been assumed that the same shocks experienced when trains pass over ordinary track would exist on rigid track. This premise appeared to be open to doubt. On the contrary, why should there be shocks on a smooth and rigid track; and without them there would be no hammering of the rail and roadbed. Furthermore, a rigidly supported rail would be free from the trouble of wave motion. As to the concrete, a 90-lb. rail should distribute its load evenly over a length of 10 in., giving 50 sq.in. of concrete to support a load of 30,000 lb., or 600 lb. per sq.in., which allowance for 50 per cent impact due to counterbalance would bring to 900 lb. This seemed reasonable in these days of 5,000-lb. concrete.

A metal seat for the rail was considered desirable, so light trusses were placed in the concrete, on which the rails were to be laid. In construction, however, it was found that these trusses were not sufficiently true in line or surface, and as the concrete could be finished to a true surface, it was finished about $\frac{1}{8}$ in. above the steel. Insulation had not been included in the original design, but became necessary when a location in block signal territory was selected for the experimental track. This was provided for by fiber plates and bushings on the fastenings. A continuous fiber plate under each rail would be required eventually; in first construction, however, a composition of asbestos and asphalt was used, but this proved unsatisfactory.

On Dec. 19, 1926, traffic was turned over this $\frac{1}{4}$-mile stretch of one track in a double-track section of main line, with trains at 45 m.p.h. The practicability of a rigid roadbed, provided it is also smooth, seems to have been proved. In a year's traffic there has been no disintegration of the concrete under the rail and no undue battering of the rails. Of 68 joints, 42 have negligible batter, whereas in 26 it ranges from $\frac{1}{16}$ in. to $\frac{3}{16}$ in. It is considered that it would be hard to find ordinary track with a better record under similar traffic. Trains ride as smoothly now as when the track was first used. Levels show a slight and gradual but fairly uniform settlement, averaging 0.085 ft.

The concrete is in excellent condition. Four slabs show hair cracks that extend the full width. In the first slab this marks a construction joint 10 ft. from the end, necessitated by delays in concreting. In the other slabs these cracks are near mid-length. None of the cracks shows signs of widening and levels fail to show any deflections near the cracks. The sound made by trains is different from but no greater than that made on ordinary track, and there are no clicks as the wheels pass over the joints.

Experience has brought to light certain lines for improvement. Insulation under the rail was found necessary, but this problem can be solved by so changing the design that the rail (or its metal bearing if this should be required) will not be in contact with or close to any metal that might convey current to the ground or to the other rail. Eliminating fabricated steel and using only ordinary reinforcing bars will simplify the design and reduce the cost. It is probable that a saving can be made in the amount of both steel and concrete. Experience has shown the importance of having close contact between the rail and its support, and of maintaining this contact by keeping the bolts tight, to reduce both lateral and vertical movements of the rail to a minimum. The anchor bolts used are $\frac{3}{4}$ in., but they should be $\frac{7}{8}$ in. or even 1 in. A few of these bolts have failed by having the heads snapped off. This occurred mainly at the ends of the concrete roadbed, where it joins the ordinary track construction and where consequently there is greater vertical motion of the rail. Other failures were due to defective bolts.

As to the advantages, it is considered that whereas there would be a considerable saving on account of reduction in train resistance, there would be a much larger saving in the cost of maintaining track and rolling equipment. Except for expense occurred in correcting obvious errors in design, such as the insulation and bolt attachments, there has been no excuse for maintenance on this section of track with concrete base or roadbed.

Stopping Leaks in 40-M.G. Reservoir by Lining With Gunite

METHODS and costs of relining with gunite a leaky reservoir forming a part of the water-works of Cambridge, Mass., were described by L. M. Hastings, city engineer, at the luncheon meeting of the New England Water Works Association, on Jan. 11.

Payson Park reservoir has a capacity of 40 m.g., a depth of 20 ft., and is in earth embankment, with stone masonry core walls, concrete bottom and slopes paved with brick and stone masonry. It has leaked for some 20 years, recently at a rate of about 0.5 m.g., and it has not been possible to maintain it at full level.

Repairs were recently completed, using a lining of 2-in. gunite, with special electrically welded steel fabric in the center of the lining fastened to the masonry surface every 3 ft. by steel expansion bolt ties. A 3-in. square mesh was used so as to give the same reinforcement in both directions. The cement and sand were machine mixed, dry, and water applied at the nozzle of the cement gun. The floor and slopes were thus treated, as well as a vertical stone division wall through the center of the reservoir, subsequent to leveling up with concrete low places in the floor.

The lump sum price for this job was $131,576 for about eight acres of area, or some $2.92 per sq.yd. Unit prices (per square yard) used in monthly estimates were: 6-in. concrete floor, $2.25; 2-in. gunite, $2.25 for floor, $2.45 for slopes and $3.15 for division wall.

A compact dense lining was obtained, weighing about 165 lb. per cu.ft., and apparently tight upon filling the reservoir with water, although the acceptance test, which permits a maximum leakage of 20,000 gal. per 24 hr.—a relatively severe requirement—has not yet been made.

American Cement Industry Report

The American portland cement industry during the month of November produced 14,449,000 barrels, shipped 11,619,000 barrels, and had in stocks on hand 15,971,000 barrels at the end of the month, according to figures released by the Bureau of Mines of the Department of Commerce. The ratio of the operations to the capacity of the industry for the month was 75.9 per cent.

Refuse Disposal Plants at Baltimore

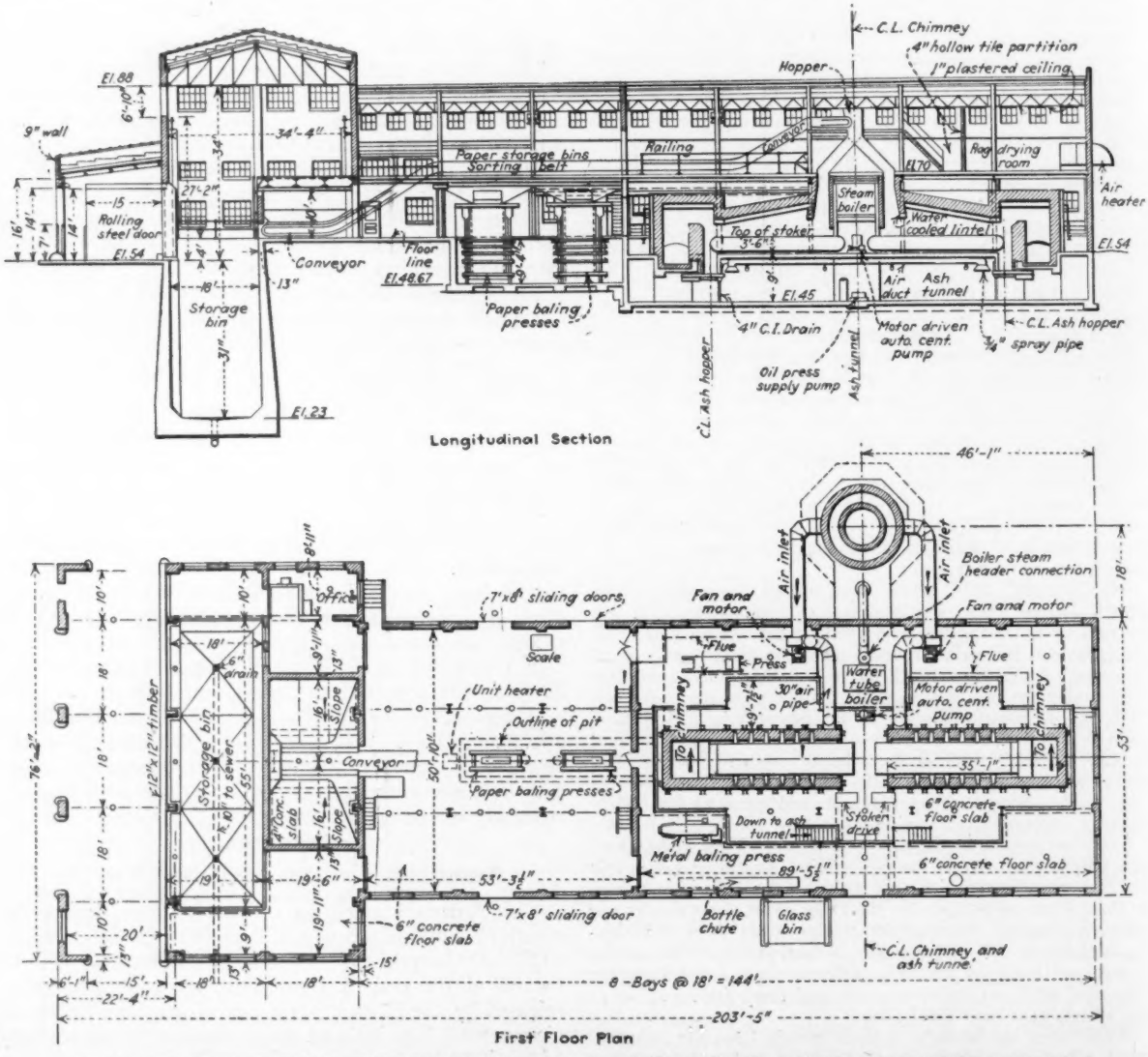
Wastes Except Garbage and Ashes Salvaged and Tailings Incinerated—One Year's Operating Data for Older Plant After Reconstruction

By Frank K. Duncan
Assistant to Chief Engineer of the City of Baltimore

THE Board of Estimates of Baltimore, Md., appropriated from the tax levy $500,000 in 1924 and 1925 for building four or five rubbish salvaging and incinerating plants to be located in different sections of the city, in order to eliminate the numerous refuse dumps which had become a nuisance and caused many complaints from citizens. The amount of rubbish to be collected was estimated to be 50,000 tons yearly. Baltimore has a population of about 817,000 and a land area of 78.72 square miles.

On March 25, 1924, the first incinerator was completed, located in the northern part of the city adjacent to an old quarry owned by the city. As the first incinerator was accepted by the city and thought efficient, a contract was let in May, 1925, for the building of a similar incinerator to be located in the southwestern part of the city but, due to the objections raised by the property holders as to its location, the contract was abrogated. Due to the difficulty of locating the incinerators and the fact that the one in operation had not proved satisfactory, a further study of refuse disposal was made by B. L. Crozier, chief engineer.

The incinerator in operation at that time was of the Davis type. The rubbish was collected by city forces, dumped on a floor at one end of the plant and pulled up on a steel conveyor belt by a drag operated from a winch. The belt carried the refuse to the second floor, where paper, rags, bottles, iron, etc., were picked off by colored labor. The tailings of rubbish fell through a chute to the floor above the flat stationary grate furnaces, then

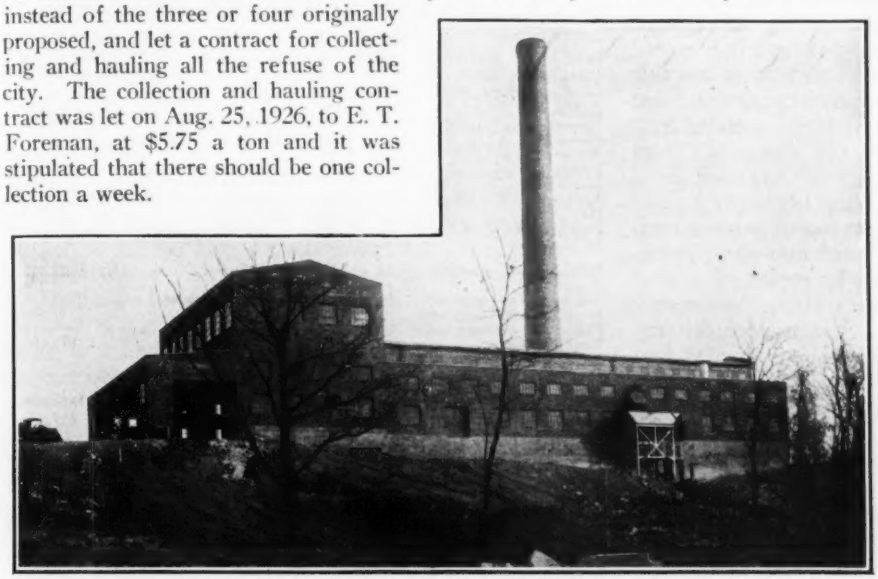


PLAN AND LONGITUDINAL SECTION OF BALTIMORE REFUSE SORTING PLANT AND INCINERATOR NO. 2

were pushed by labor to the charging holes. The ash was carried from the furnaces by hand barrows to the dump near by. These furnaces, although they would satisfactorily consume a limited amount of rubbish in dry weather, were a complete failure when the rubbish was damp or wet. The fire often went out, whereupon it was necessary to put men in the incinerator to shovel out unburned refuse. Because there was no storage, the plant could be operated only while refuse was being delivered.

The estimated amount of rubbish delivered to the incinerator in 1925 was 64,811 cu.yd., the cost of operation was $31,655, and the amount of salvaged material sold was $24,163, giving a net cost of $7,492.

It was decided by the chief engineer to increase the capacity and efficiency of the existing plant, build one additional incinerator in the southeastern part of the city instead of the three or four originally proposed, and let a contract for collecting and hauling all the refuse of the city. The collection and hauling contract was let on Aug. 25, 1926, to E. T. Foreman, at $5.75 a ton and it was stipulated that there should be one collection a week.



SECOND MUNICIPAL REFUSE SALVAGING PLANT WITH INCINERATOR FOR TAILINGS AT BALTIMORE, MD.

No garbage or ashes received. On arrival at plant, refuse weighed and dumped into storage bin. Lifted from bin by toothed clamshell bucket, dumped on conveyor leading to picking belt. Tailings lifted by conveyor and dumped into furnaces.

First Incinerator Remodeled—In 1926 the first incinerator was remodeled by building a storage bin holding 175 tons of rubbish, which increased its operating time from 8 to 24 hr. a day; by tearing out the two flat-grate furnaces and installing one Moore chain-grate furnace with a capacity of incinerating the tailings from 200 tons of rubbish per 24 hr. in dry weather and about 150 tons in wet weather; by providing forced draft and a steel belt to convey the ash to the dump; by extending the conveyor to the bottom of the storage bin, and installing scales for weighing the rubbish. The rated capacity of the Davis incinerators was 40 tons of mixed rubbish in 8 hr., or 5 tons an hour, for both units. The installation of one Moore chain-grate furnace has increased this capacity to 8 tons per hour, and the daily capacity from 40 to 200 tons, the storage bin increasing the working day from 8 to 24 hr.

The remodeled incinerator was put in operation on Oct. 1, 1926. To aid combustion in wet weather, waste crankcase oils from automobiles are poured on the rubbish in the charging hole, which increases the efficiency of the furnaces at little cost. Operating data for the first full year are given in the accompanying table.

The hauling of the rubbish by contract has been very satisfactory, causing a regular daily flow of rubbish to the incinerator. The contractor took over the work by districts, which accounts for the increasing amounts of rubbish received each month. The rubbish from about 50 square miles is now being hauled to the incinerator. The unusual amount of wet weather in the spring and summer of 1927 and the low price of the paper market is the cause of the receipts from salvage being lower than was estimated.

Second Incinerator—On April 27, 1927, a contract was awarded to Charles L. Stockhausen & Company, Inc., for the building of Incinerator No. 2, with a rated capacity of 250 tons per 24 hr., for $218,242. It is being built on land owned by the city, located on the top of high ground, with a ravine and a large area available for the disposal of the ash for many years. If thought advisable, when the fill is made a track can be laid alongside of the incinerator to connect with the Baltimore & Ohio Railroad near by. The 15-ton scale house is located inside of the proposed building line of the Philadelphia road as the road is to be widened. The plant is set back 140 ft. from the proposed widened road and is 183 ft. 4 in. long and 53 ft. wide, except the front portion housing the bin and crane, which is 76 ft. 2 in. wide. The walls of the building are constructed of red brick with steel sash. The floors are of reinforced concrete. The short-span precast gypsum roof is supported by steel trusses.

The rubbish on arriving at the plant and being weighed, is dumped into a concrete bin, 18x51 ft. in plan and 31 ft. deep, holding about 150 tons of dry rubbish. A 2½-cu.yd. toothed clamshell bucket is provided to lift the rubbish from the storage bin, operated from a 4-ton, four-motor electric traveling crane. The bucket deposits the rubbish in a small bin at the end of the steel conveyor belt. The belt and the men who place the rubbish on the belt are protected by a steel canopy. As the belt, 48 in. wide and operated by a 7½-hp. motor, with automatic stop control, moves at a speed of 30 ft. per min. the paper, rags, tin cans, bottles and metals are picked off by colored women and deposited in their respective bins or receptacles. The worthless rubbish falls from the belt into a hopper, which has a swinging gate to divert it into the charging hole of either furnace.

The charging holes are at one end of a chain-grate stoker which moves at a speed of from 2 to 8 in. per min. As the rubbish moves with the grate, combustion takes place and the combustible matter is incinerated. The ash falls from the end of the grate into a hopper controlled by a gate. When the gate is opened, the ash falls into a 1-yd. dump car on rails and is transported through a tunnel under the furnace to the dump alongside the plant.

OPERATING DATA FOR BALTIMORE RUBBISH INCINERATOR NO. 1 FOR FIRST FULL YEAR IN USE ENDING SEPT. 30, 1927

Personnel per 12-Hr. Shift

	Wage per Hour	Wage per Shift
1 foreman	$0.66⅔	$7.98
1 assistant foreman	.50	6.00
1 weighmaster	.50	6.00
1 clerk	.50	6.00
1 furnaceman	.65	7.80
16 pickers (colored women)	.20	38.40
26 laborers	.43¾	136.50
		$208.68

The incinerator is operated in two shifts per day. Except for the foreman and furnaceman, the shift averages about 10 hr., but on the night shift the weighmaster, clerk and one laborer are not on duty. Thus the average daily payroll, allowing for lost time of pickers, etc., amounts to about $320, with no allowance for administration, depreciation and interest on investment.

Each of the two up-stroke paper balers is operated by a 10-hp. electric motor. They are located under the rubbish conveyor belt. The paper is tossed by the pickers into bins back of them, alongside and under the belt, from which it is placed in the balers. The baled paper leaves the presses on the lower floor, where it is stored until shipped. The rags are tossed into bins on one side of the belt and, if wet, are then taken to the drying room before they are placed in a baler, which is operated by a 7½-hp. motor. Tin cans are tossed into a large bin, from which they are fed into a metal baler operated by a 10-hp. motor. The pressed bales are 12x10x14 in. and weigh about 35 lb. each. Bottles are placed in containers, carried to the sorting table, separated into sizes, put in crates and slid to the lower floor by means of a steel chute. Broken glass is thrown into a 51-ton duplex steel bin located outside of the building, from which delivery is made to trucks when sold. The bin is divided into two compartments, so the broken flint glass can be separated from the tinted glass, as the clear glass has a higher sale value. Copper, aluminum, cordage, iron, shoes, etc., are separately bagged and stored on the lower floor until sold.

There are two Moore chain-grate type incinerators, each having a capacity to incinerate the tailings from 125 tons of mixed rubbish in 24 hr. containing not more than 30 per cent moisture or non-combustible material. The furnace chamber is 7 ft. 5 in. by 25 ft., with firebrick lining to withstand a temperature of 3,000 deg. F. The charging holes are 30x89 in. There are six 8x8-in. cast-iron inspection doors on either side of the furnace for slicing and raking the fire. The ash hopper is cast iron, lined with special tile, with a water spray for quenching the ash, and a 3x4-ft. water-collecting discharge gate at the bottom, power-operated by means of a piston and cylinder, using oil as an operating medium.

The chain-grate stoker consists of a heavy non-sifting grate, composed of chain links mounted on 1⅜-in. steel bars, which take the mechanical stress. Removable top clips support the fuel bed, so constructed that the openings in the fuel-supporting surface of the grate, while rounding the pulleys at the discharge end of the stoker, form closed sockets so that the ash, small pieces of iron, etc., fall outwardly and away from the grate and not through them to the inner part of the grate structure. The stoker is operated by a 3-hp. motor.

The stoker is subdivided into seven zones extending crosswise or at right angles to the direction of grate travel. The six rear zones have main dampers connecting with the main air pressure duct or wind box. Each zone is further controlled by dampers to regulate and direct the blast to the center or side of the grate, or to both, as conditions in the furnace demand. The air zones are connected with a wind box on one side of the stoker, into which the air comes from the forced-draft fan with a capacity of 8,500 cu.ft. of air per minute, at 70 deg. F., when operating at a speed of 1,160 r.p.m. against a 3-in. static pressure. Each fan is operated by a 7½-hp. motor.

The combustion chambers are built integral with the furnaces and are connected to flues having an area of 20 sq.ft. In the bottom of the combustion chambers a soot gate is provided, so that the chambers can be easily cleaned.

The chimney is of the radial-brick type, 150 ft. high, 7 ft. inside diameter at the top. There is an 8-in. air space at the top, increasing from top to bottom with the taper of the chimney, between outside of firebrick lining and inside of radial brick, connected near the top of the chimney with cast-iron air ports with a total cross-sectional air opening of 20 sq.ft. This space is for the purpose of heating the air which supplies the forced air fans. The furnaces have a duplex type continuous recording thermocouple pyrometer, registering from 75 to 2,400 deg. F.

The building is heated by means of steam generated in a waste-heat water-tube boiler, having a rated capacity of 14,000 sq.ft. of direct steam radiation, connected to the incinerator flues. A two-pipe low-pressure gravity return system to a receiver with a 1-hp. motor-driven automatic centrifugal pump for returning condensation to boiler is provided. The plant is lighted by electricity, all current, for both light and power, being purchased from the local electric light and power company. The plant was put into operation Dec. 21, 1927.

C. F. Goob is the present chief engineer of the city, having assumed office Oct. 1, 1927.

MONTHLY TONNAGE OF RUBBISH DELIVERED TO INCINERATOR

Includes all refuse collected, except garbage and ashes. Average weight, 200 to 250 lb. per cu.yd., when dry.

October	1,178	July	4,152
November	1,575	August	4,611
December	2,036	September	4,366
January	2,267		
February	2,308	Total for year	38,257
March	3,154	Average per month	3,190
April	3,583	Average per day (310 working days)	123
May	4,522		
June	4,505		

Cost of Operation

Weighing and unloading	$3,660	Miscellaneous	$5,863
Feeding belt	10,382	Supervision	3,878
Picking and baling paper	15,316	Supplies and repairs	3,330
Picking and baling tin cans	9,784	Power	3,000
Picking and sorting bottles	4,841		
Tending furnace	5,493	Total	$71,105
Ash handling at dump	5,558		

Salvaged Material Sold, and Amount Received

	Amount, Lb.	Revenue
Paper	6,039,198	$17,476
Rags	371,127	6,428
Bottles (number, 680,688)	510,000	4,933
Cordage	16,966	113
Leather	94,965	170
Burlap	50,235	510
Carpet	45,021	464
Tin	4,266,855	8,339
Broken glass	1,970,150	4,303
Metals	311,928	2,915
Rubber	34,560	579
Cotton and hair mattresses	14,626	287
Total	13,725,631	$46,517

General Summary

Cost of operation	$71,105
Total receipts	46,517
Net cost	$24,588
Cost per ton	$0.643
Collecting and hauling (contract), per ton	5.750
Total cost per ton	$6.393
First cost of incinerator	$105,000
Remodeling	112,000
Total cost	$217,000
New construction, 1927	3,500

As the cost was paid for out of the tax levy, there are no interest charges, except the earning power of the money invested, legal rate, 6 per cent. City borrows money at from 4 to 5 per cent.

High-Strength Steels for Modern Bridges

Trend in Building With Special Steels and a Few Problems Metallurgists Must Solve for the Bridge Engineer

By L. S. Moisseiff

Advisory Engineer of Design on Hudson River Bridge, Port of New York Authority

(From a paper presented to the New York Section, American Society for Steel Treating)

THE BEGINNING of modern bridge engineering dates from the time when a bridge ceased to be for its builder merely a mass and began to be realized as a force clad in stone, wood or iron. It began to be viewed mentally as a system of forces in equilibrium. Then with the introduction of the present articulate structure, the members began to lose in size and the demand on the material to increase. Higher-strength materials became desirable, both for strength and for economy.

Since with increase of span a bridge becomes heavier, more than in a simple proportion (in the Hudson River bridge the ratio of dead load to live load is five to one), the aim of bridge engineers has always been to reduce the weight of the longer-span bridges by the utilization of materials of higher strength. As a rule, the new material must be produced under special conditions, with more care and with increased rejections, all of which result in a higher cost of production. In time perhaps its successful production and fabrication become established and the price decreases, permitting its use for shorter-span bridges and other structures.

Nickel Steel—In the design of the Queensboro bridge, New York City, in 1902, nickel steel was for the first time used in the eyebars, with a specified elastic limit of 48,000 lb. for full-sized tests of 16x2 in. bars, an ultimate strength of 85,000 lb. per sq.in., an elongation of 9 per cent in 18 ft. and a reduction of area of 40 per cent. Nickel steel was also adopted for the riveted shoes on top of the towers. About 6,000 tons of nickel steel were used in a total of 53,000 tons. The wire cable design of the Manhattan bridge was based, in 1906, on stiffening trusses with nickel steel for chords and web members. In the Quebec bridge, about 16,300 tons of nickel steel were used in a total of 66,500 tons. For the 668-ft. span simple trusses of the Municipal bridge in St. Louis, nickel steel throughout was used, for eyebars as well as for compression members. More recently the chords of the stiffening trusses of the Delaware River bridge in Philadelphia were built of nickel steel.

In 1915, Mayari steel, a natural alloy of nickel-chromium steel made from an ore mined in Cuba, was used in the Harahan bridge at Memphis, Tenn., meeting specified requirements of 55,000 lb. per sq.in. elastic limit and 85-100,000 lb. per sq.in. ultimate strength on standard test specimens, and of 47,000 lb. and 80,000 lb. per sq.in. minimum respectively on full-sized eyebars. As a natural product this material has the advantage of low cost, but it also has the disadvantage of non-uniformity.

Silicon Steel—Also in 1915, silicon steel was used for the first time, on the Metropolis bridge over the Ohio river. Specifications required a yield point of 45,000 lb. per sq.in., ultimate strength of 80,000 to 95,000 lb. per sq.in., a reduction of 35 per cent, and elongation of 17 per cent. The Cincinnati bridge, in 1917, used silicon steel of the same requirements. At the present time, producers generally charge for it a differential of not more than a cent per pound over the price of carbon steel. It is an economic and dependable material. It has been used to a large extent in the recently completed Delaware River and Carquinez bridges and in the Hudson River bridge now under contract, in the latter 32,000 tons being used in the towers and floors.

Heat-Treated Steel—Heat-treated carbon steel, introduced about 12 years ago, is available in two grades, meeting the following minimum requirements in full size tests:

	Grade 1	Grade 2
Tensile strength, lb. per sq.in.	105,000	80,000
Yield point, lb. per sq.in.	75,000	50,000
Elongation in 18 ft., per cent	5	8

The second grade has been used in a number of bridges and recently in the Carquinez Straits bridge, where about 1,400 tons of bars were required. About 800 tons of grade 1 bars were used in the Florianopolis bridge in Brazil.

While the record of tests of full-sized heat-treated eyebars is good, it should be considered that each bar is heat treated separately and that tests, therefore, do not represent samples of groups of identical bars, but only themselves individually. It seems to the speaker that a more reliable method of selecting and testing should be evolved.

Wire—Since White and Hazzard, in this country in 1816, and Séguin Frères, in France in 1826, introduced drawn wire for bridge cables, suspension-bridge cables have with few exceptions been built of wire. Undergoing many improvements, available bridge wire has gradually attained a high degree of perfection and strength. From the time of the use of wire in the Brooklyn bridge, the evolution has been in the direction of a higher elastic limit and greater strength. No new methods or new alloys have been brought forward, with the exception of a recent method of heat treatment. The growth in the ultimate strength of wire used in the largest suspension bridges is shown in the following tabulation:

Brooklyn	1880	160,000 lb. per sq.in.
Williamsburg	1900	200,000 lb. per sq.in.
Manhattan	1906	210,000 lb. per sq.in.
Delaware	1923	215,000 lb. per sq.in.
Hudson	1927	220,000 lb. per sq.in.

Doubt has been expressed as to the effect of time on heat-treated steel. Naturally engineers are anxious for positive information. I believe it is up to the manufacturers to inaugurate exhaustive time tests to settle the question.

Bridges should be strong enough to carry their loads and stiff enough to act well as structures and to remain comfortable for travel. For stiffness, not a high-strength material is required, but rather sufficient material, properly placed, of low strength, good ductility, and low in cost of manufacture and fabrication. Common structural carbon steel is mostly used except for those details, such as splices and gussets, which must transfer stress directly. For carrying strength, the higher-strength metals are desirable.

Rivets and Castings—To transmit the greater stresses which are sustained by members made of higher-strength steel, riveted connections of greater strength are naturally required. More rivets and larger rivets have been used but without satisfaction. Nickel-steel rivets have been largely used, and when carefully handled and driven with thorough inspection have given good results. Still many

are not satisfied with nickel steel as a riveting material and there is a manifest demand for a higher-strength rivet steel which can be conveniently heated without forming scale, will easily upset and fill the hole, and will furnish a dependable rivet when in place.

The growth of bridges has made a greater demand on castings suitable for bearings and saddles. Since steel castings can be made of substantial thickness, there is generally no difficulty in providing sufficient section to keep the unit stresses down, so that the question is altogether one of dependability rather than of high-strength material. Cracks and even failures appear in important castings days and months after they have been annealed and passed by experienced inspectors. It is evident that there is an urgent need for more reliable steel castings.

The demand for many highway structures and the fact that the longer of these must be toll bridges financed from their earnings makes it necessary that they be economically planned and maintained at low cost. This points to high-strength structural steels as a major source of economy.

American Society of Civil Engineers Holds 75th Annual Meeting

Sessions Given Over Largely to Well-Attended Meetings of the Technical Divisions—Special Committees Report Progress—Unusually Large Number of Members Registered

MARKED by no special ceremony to record the completion of another quarter century of activity, the 75th annual meeting of the American Society of Civil Engineers last week brought together an unprecedented attendance, about 1,900. It was distinguished also by notable increase in interest in the sessions of the technical divisions. A report of the opening meeting, of the conferring of honorary memberships, the awarding of medals and prizes and the election of officers was given in the news pages of last week's issue.

The general session on Wednesday afternoon was devoted to the presentation and discussion of the reports of special committees. Morris Knowles reported that the committee on city planning of Washington, D. C., had been in communication with the Capital Park and Planning Commission concerning the proposal to develop powers of the Potomac River at Washington, and that while the committee indorsed the efforts of the commission to protect the scenic values of the Potomac River, it realized that it was desirable to develop the power possibilities of the river if that could be done without detriment to its recreational value. With that idea in mind the committee recommended that any preliminary permit issued in connection with such power development should include a proviso that the applicant be required to make a study to determine how both ends could best be served.

The special committee on flood protection data renewed its recommendations that a full-time engineer be employed to compile and study statistics on flood flow, as it is next to impossible to carry on the work as a committee operation. After considerable discussion the meeting went on record as favoring a plan to urge upon Congress the necessity for adequate and continuous appropriations for the collection and compilation of flood data. This is along the lines of action taken by the board of direction at its meeting earlier in the week in indorsing the new bill. Printed reports by the committee on irrigation hydraulics and on concrete and concrete arches were distributed but were not discussed on the floor.

Thursday was given over to concurrent sessions of the technical divisions. These meetings were unusually well attended and discussion, in general, was active. Reports of them are given herewith. Friday was given over to a trip by bus through the Holland tunnel to the new power plant of the Public Service Corporation of New Jersey, to the cable-making plant of the Western Electric Company, and to the assembly plant of the Ford Motor Company, all at Kearny, N. J. On Saturday all who wished to do so were taken down into the new Eighth Ave. subway to see some of the complicated layouts south of Columbus Circle and then across town through the tunnel which is being driven through 53d St., proceeding east as far as the heading under Third Ave.

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Technical Expansion

Expansion of the society's technical activities was authorized for the board of direction, as noted last week. The president was authorized to appoint a committee of seven charged with the following responsibilities:

1. To study and report on the present organization and conduct of the technical activities of the society, these being understood to comprise publications, technical meetings, research, special committees, joint technical activities with other societies, technical divisions, and other technical activities.

2. To draft and recommend a proposed plan of organization through which to stimulate, supervise and coordinate all the technical activities of the society. In preparing this plan special attention to be devoted to strengthening the work of the technical divisions; to stimulating and supervising committee activities; to avoiding wasteful duplication of effort; and to providing a sound basis for the expansion of the society's technical work.

The board authorized an appropriation of $1,500 to defray traveling and other necessary expenses of the committee. Its final report and recommendations are to be submitted to the 1928 summer meeting of the board of direction.

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Construction Division

Through a change in the announced program, the Construction Division devoted much of its session to a discussion of college courses for construction engineers. Prof. C. M. Spofford, of Massachusetts Institute of Technology, outlined the course in construction engineering given at his institution. This course gives the

student a thorough training in fundamentals, a background of general education, mental training subjects, and only such details as serve to illustrate principles. The required courses include general subjects, scientific, engineering and business subjects. Professor Spofford outlined in detail a proposed co-operative course in construction engineering which would require five years' work and lead to a Master of Science degree. The course would provide alternate periods of from fifteen to twenty weeks at school and with the industry.

The course in building construction at the Sheffield Scientific School was outlined in a paper by Prof. Theodore Crane, of Yale. This course includes field methods and is arranged to give the student a broad viewpoint. After practically a straight civil engineering course for the first three years, the student specializes in his senior year only.

Discussion of these papers brought out strong opinions against specialized courses for engineering students. Among the speakers was Dean H. J. Hughes, of the Harvard school of engineers, who stated that he was a proponent of the simple, non-specialized four-year course in engineering. Dean Hughes stated that at Harvard 80 per cent of the courses in civil, electrical and mechanical engineering are alike. L. W. Clarke, professor of mechanics, Rensselaer Polytechnic Institute, held that there is no need for a specialized course in construction engineering. M. S. Ketchum, dean of the College of Engineering, University of Illinois, called attention to the difficulty in teaching construction methods because of the lack of suitable literature on the subject. Educators must know more about engineering, he stated, and the curriculum should be arranged to fit the staff of the institution as well as the students' requirements.

A paper on plant layout as applied to structural steel apartments and office buildings was given from the viewpoint of the general contractor, by John R. Kilpatrick, vice-president of the George A. Fuller Company. Attention was called to the importance of keeping job labor to a minimum by use of machines wherever possible and carrying out as many labor operations as possible in the shop. Mr. Kilpatrick pointed out features in construction which have remained the same throughout the ages, such as the method of handling brickwork and stonework, whereas other features, such as polishing, cutting and hoisting, have been developed highly. In laying out a job, the hoist and runways should not interfere with the mechanical work. The chief construction plant in tall office or apartment buildings is the hoisting equipment and its location is of extreme importance. Removal of rubbish was another point mentioned, in which rubbish chutes were suggested emptying into bins on the second floor. Trucks can then bring in material into the building and be loaded with rubbish from the bins when leaving, thereby saving the extra hauling required to remove rubbish at night. More than one entrance to the building is not required and the expense of additional checkers and watchmen is saved.

In the discussion of Mr. Kilpatrick's paper the subject of chuting concrete was brought up and interesting experiences were presented. Several mentioned having abandoned the chuting method and gone back to the use of a hoisting tower and the wheeling method. This led to further discussion in which the relative merits of dry and wet concrete were mentioned. That mechanization might be carried to an extreme was mentioned by F. O. Sprague, who stated that it was a research problem of magnitude.

Lack of time prevented the session from continuing the discussion, which indicated that the general subject of plant layout and the use of equipment is of major importance to the construction industry.

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Power Division

The whole time of the Power Division session was given over to the subject of the use of small-scale models in hydraulic studies, first in the studies for the spillway of the Cheathaven dam in Pennsylvania and the Martin dam in Alabama, and second, in predicting results to be obtained in the test on the Stevenson Creek dam in California. The greater part of the time was devoted to the first subject, to the presentation and discussion of a paper by F. W. Scheidenhelm and C. A. Wright on the tests made at Cornell University Hydraulic Laboratory to determine the best manner in which to prevent scour at the toe of the Cheathaven dam. The model was made to a scale of 1 to 16 and was set in a flume with glass sides which made it possible to observe what took place below the water surface. The bottom of the flume below the dam was overlaid with sand in some tests and with gravel in others. Co-ordinates marked off to correct scale on the glass sides of the flume made it possible to sketch the results accurately for future study and comparison. One notable result of the use of glass sides was the observation that surface conditions may not, in some instances, indicate what is going on at the bottom of the channel; that heavy scour may occur with a fairly quiet surface.

The Cheathaven dam is of ogee section with tainter gates on the crest. As a result of the test the adopted arrangement at the toe of the dam for dissipating the energy of the water was a stepped bucket from which the water discharges horizontally into a pool ending in a baffle wall. For part of the channel width this wall is solid, with its top sloping up; for the remainder of the channel it has vertical wall with orifices cut through from face to face. The efficiency of the arrangement depends upon maintaining the pool level below the dam above a prescribed elevation and consequently the method of operating the crest gate is of importance. P. F. Kruse described the program of operating the gates which has been worked out, and also told how closely the results now being obtained at the dam check those obtained in the tests at Cornell.

Tests made in the hydraulic laboratory of the Alabama Power Company on models of Martin dam to a scale of 1 to 100 and 1 to 36 were described in a paper by I. A. Winter presented by J. H. Winter.

Clemens Herschel added zest to the meeting by comments to the effect that he was glad to see the day when so much time was being devoted to tests on models, but that the younger men should not think that they were attempting something original in their studies, that every design consideration outlined in the description of Willwood dam reported in *Engineering News-Record* Oct. 27, 1927, p. 660, was practically the same as that used at Holyoke, Mass., in studies for the design of that dam 42 years ago.

Speaking of scour below overfall dams (it having been stated earlier in the meeting that the pool below Niagara Falls was as deep as the falls is high), Mr. Herschel said that in the old days when many large dams of the overflow type were used, dam builders had a rule that provision must be made for the pool below to scour to a

depth equal to the height of the overflow—"which Niagara Falls only confirms," added Mr. Herschel.

The use of a celluloid model in checking results obtained at the Stevenson Creek dam was the subject of a paper by Prof. G. E. Beggs, of Princeton University, under whose direction the tests were made. His model was built to a scale of 1 to 40, with mercury used to get pressures corresponding to those obtained with water on the full-scale test dam. The results obtained at Princeton were in close agreement with those obtained at Stevenson Creek, and Professor Beggs believes that if care is taken in the preparation of such models and in evaluating the results obtained, they can be used to predict what will be obtained under actual conditions.

W. A. Slater, of the Bureau of Standards, who took part in the tests on the Stevenson Creek dam, stated that when the question was raised as to why $100,000 should have been spent in that test whereas the Princeton work cost only $2,000, it should not be overlooked that only by the Stevenson Creek test was it possible to prove that the Princeton results were correct. In connection with these tests Alfred D. Flinn, of the Engineering Foundation, stated that another series of tests is to be undertaken at the University of Colorado under the auspices of the Bureau of Reclamation. The Engineering Foundation will participate in this work and Prof. C. D. Marx, of Stanford University, is chairman of the committee which will represent the Engineering Foundation.

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City Planning, Survey and Mapping and Highways

That co-operative effort is the biggest single need in city planning was emphasized at the joint meeting of the City Planning Division and the Highway Division Thursday morning and again at the joint session of the Surveying and Mapping Division and the City Planning Division Thursday afternoon. In the production of base maps, in the formulation of comprehensive and detail plans, in the prosecution of work, co-operation is needed. Discussing A. A. Shurtleff's paper on "The Relation of the Landscape Architect to the Allied Professions in City Planning," Harold M. Lewis, speaking for Frederic A. Delano, chairman of the Regional Plan of New York and Its Environs, asserted that the law, social economics, social welfare and the science of the engineer, landscape architect and city planner are all necessary constituents of successful planning. Mr. Delano's discussion, read by Mr. Lewis, raised the question as to the equity of certain zoning ordinances that, through use distribution, put high and low valuations on property in the same area. One of the greatest evils of zoning, he intimated, was the presence of dead areas close to those of high valuation, made so largely through speculation.

At the morning session Stephen T. Mather, director of national parks, in discussing "Engineering Features of the Development of the National Parks of the United States," told of the impetus that has been given park highway development in the past two years, through the co-operation of the Bureau of Public Roads. That latter bureau has loaned its construction services to the park department and highways are now designed and built with a view to assuming adequate park roads without injuring the beauty of the landscape through careless location or the spoiling of excavated material at the roadside. Mr. Mather said that in 1925 the first road contract was let by his bureau and that now it has embarked on a program of large improvement, the first piece of work being the construction of 8½ miles of highway in Zion National Park, estimated to cost $1,250,000. Mr. Mather outlined the extensive activities in which his bureau engages, embracing (besides highway design and construction) snow removal, dust prevention, installation of sanitary services, garbage disposal, water supply, inspection of camp kitchens, power development, trail building, hospitalization and the furnishing of educational facilities and those for carrying out community plans. Moving pictures showing national park highway construction were exhibited by H. K. Bishop, chief of the division of construction of the Bureau of Public Roads.

At the afternoon session two papers were presented: one describing the character of base maps for regional planning by Harland Bartholomew, consulting engineer, St. Louis, and "The City and Regional Survey," by R. H. Randall, of Toledo. Discussion of these papers led to lengthy consideration of the value of aërial photography in mapping. C. H. Birdseye, chief topographic engineer of the U. S. Geological Survey, crystallized the thought of one group by saying he believed that the chief value of aërial work was in filling in minor detail and that the extent of usefulness of the aërial photograph had about been reached in extensive accurate mapping.

The most important contribution to the general discussion of mapping was given by E. O. Heaton, of the Coast and Geodetic Survey, who pleaded for the establishment of separate bureaus in city governments which would be outside the influence of political change so that city surveying and mapping would be continuous and records could be adequately and uniformly kept. Emphasis was laid in a number of short discussions on the necessity of education of the public as to the need for city mapping.

"Economic Comparison of Various Types of Road Surfacing" was the subject of a symposium before the Highway Division meeting on Thursday afternoon. Paul D. Sargent, former chief engineer of the Maine State Highway Commission; Frederick E. Everett, commissioner and chief engineer of the New Hampshire State Highway Department, and H. J. Kuelling, Wisconsin state highway engineer, presented papers giving, for their respective states, the economic factors considered in road surfacing, construction and maintenance costs for different types of surfacing and the tire and fuel costs for operating vehicles over these roads. The experience of these three indicate that operating costs were almost invariably much higher than those for construction and maintenance. The comparison was arrived at through traffic counts to give an average per-mile yearly travel. In the discussion of these papers it was brought out that the highway problem is being viewed from a broader viewpoint by most engineers, the economic factor having become a major consideration. Traffic counts were shown to be of little value in considering suitable road surfacing, unless distinction is made between truck and light car traffic. A suggestion was made that road surface selection be considered from the standpoint of returns on capital investment. The type of surface selected should be that which produces the maximum return, represented by the saving in maintenance and vehicular operation, in proportion to the capital invested in the road. A. R. Hirst, former Wisconsin state highway engineer, stated that within the next ten years there will be a return to the toll method of road financing, somewhat similar to

the method used in connection with many highway bridges. This will be brought about, he stated, by the apparent unwillingness on the part of the public to vote large expenditures for road construction and the apparent favor which the public has for making small payments over an indefinite period.

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Structural Division

Three subjects of unusual interest made the proceedings of the Structural Division of noteworthy strength and appeal. The design of the piers for the new Hudson River bridge at Fort Lee was reviewed by L. S. Moisseiff, advisory engineer of design to the Port of New York Authority; the final report of the Florida hurricane committee was rendered by the chairman, H. G. Balcom; and the main elements of design and erection of the Carquinez Straits cantilever bridge were described by D. B. Steinman, designing engineer for the owners, and C. F. Goodrich, assistant engineer for the American Bridge Company.

The Hudson River bridge towers consist each of sixteen columns, placed in four longitudinal and four transverse lines, connected into an integral tower structure by bracing. The roadway passes between the inner longitudinal lines of columns, and directly over these columns are located the cable saddle supports. The complete design calls for a stone-faced concrete incasement of the tower, though the incasement may be omitted in the first stage of construction. There was much discussion a year ago concerning the division of cable load between the inner and outer columns, under the arrangement which places the cable saddles directly over the inner columns. Mr. Moisseiff's paper gave the results of elaborate calculations of the load distribution, the tower being analyzed as a structure with redundant members. Comparative studies of modifications in the arrangement of the tower portals and bracing showed that the gross range of variation in column working stress which would result from these several variations (with the actually adopted column section) does not exceed 3 to 4 per cent, some of the variations being upward and some downward, with the stress curve for the adopted tower arrangement lying near the mean of the range.

To supplement the analytical calculations, a mechanical analysis of the tower was also carried out. For this purpose one of the four transverse bents was simulated by a model cut out of a sheet of ¼-in. celluloid 20x50 in. In order to avoid disturbances due to any buckling tendency of the relatively thin sheet in case of compressive loading, the model was inverted and tested in tension by suspending its base from a fixed support and hanging the load from the points representing the cable saddles. The load was such as to produce a fairly high stress in the celluloid, yet safely within the elastic limit of the material, and the extensions of the material were then directly measured by sensitive extensometers. The results checked the analysis very closely, confirming the dependability of both methods of analysis. Mr. Moisseiff called particular attention to the common term used for redundant structures, "statically indeterminate," and suggested that in the minds of some engineers and many laymen this term implies uncertainty or even lack of safety. He remarked that the resistance of such a structure is as definite and therefore as determinate as that of any other form of structure, and that it is usually more safe rather than less safe than a statically determinuate structure.

Charles E. Fowler, C. E. Chase, E. W. Stern and others discussed the paper. Mr. Stern said that criticism of these towers lies not against the engineering but against the architecture, and expressed the opinion that covering steel towers with a stone inclosure will make the towers a sham. He claimed further that stone towers for suspension bridges have given trouble wherever used. Mr. Chase, however, pointed out that masonry towers become economically possible in the case of the Hudson River bridge because of the proportions of side and main spans and the unloaded backstays. Mr. Fowler paid a tribute to the long work of Gustav Lindenthal in developing plans for a Hudson River bridge, and said that Mr. Lindenthal's dreams have been the means of bringing about the present bridge.

Mr. Fowler also announced a donation to the society for a prize, in memory of his mother.

Florida Hurricane Report—Study of the structural effects of the Florida hurricane of September, 1926, has been carried on by a committee of the Structural Division during the past year. The report of this committee was confined to the effects on office buildings in Miami, and the conclusions to be drawn therefrom with respect to storm-wind pressure and elements of wind-bracing design. H. G. Balcom, chairman of the committee, reported that the behavior of the buildings and calculations of their strength indicate that an estimate of 50 to 60 lb. per sq.ft. is probably as good as can be made for the wind pressure actually exerted in that storm, though this pressure may not have existed on any large area at one time. The report dealt specifically with the Meyer-Kiser and Realty Board buildings, both of which were seriously injured by the storm. In the Meyer-Kiser building, both the windbracing provided and the details of this bracing were found to be inadequate; the report states that it is evident "that there was no adequate windbracing in this building, and the details vitiated any advantages from the attempt which was made. It is difficult to understand how any loans or hurricane insurance could have been obtained on this building, and the results indicate forcibly the desirability of engineering advice for financial organizations as well as for the owners."

On the other hand, the Realty Board building is declared to have represented a genuine effort to brace the building properly, and its behavior gave "greater evidence of lack of stiffness than of lack of strength." A number of the wind-connection details, though following conventional practice, were obviously weak due to thinness of connection angles or column flanges. The committee concluded as to this building: (1) That two unbraced panels in the rear part of the building proved to be an element of weakness, (2) that the front and rear walls should have had stiffer bracing to prevent cracking of the walls, and (3) that provision should have been made at the stair well for wind transfer from rear to front sections of the building without putting undue stress on one particular beam. Further, both this building and the Meyer-Kiser building should have been provided with longitudinal bracing, "as this would have had a strong tendency to resist torsional racking of the building." Comparison was made with the tower of the Daily News building in Miami, which is 40 ft. square and about 225 ft. high. This tower was designed for a wind pressure of 20 lb. per square foot in either direction at a unit stress of 24,000 lb. per sq.in. in the steelwork, but the details as well as the main members were designed to be adequate for all elements of wind-stress transfer,

and effort was made to have the connections stiff as well as strong. Moreover, the walls were built of heavy interlocking tiles instead of thin-web partition tiles. The building suffered no structural damage. Disregarding the strength of the walls, the framework of this building would not show distress until a wind pressure of about 30 lb. per sq.ft. on the entire surface was exceeded.

The conclusions of the committee lay stress on the necessity of adequate windbracing in high buildings, the importance of careful design of details, the need for specially stiff bracing in the outside walls to prevent injury to the masonry, and the desirability of symmetrical arrangement of the bracing so as to prevent twisting.

Prof. F. O. Dufour, of Lafayette College, in discussing the report, outlined his observations of the Meyer-Kiser building made shortly after the storm. He spoke particularly of the evidence of effective distributing action of the floor slabs as horizontal girders. E. W. Stern told of his observations and conclusions as to the St. Louis tornado of 1896. He concluded that every bent should be braced in both directions and that ordinary seat and top angles are utterly inadequate as windbracing. In some cases he has observed that operation of erection derricks pulled the framework 6 in. out of plumb, while substantially designed and detailed framework will demonstrate its rigidity by its resistance during erection.

The final item of the program, the description of the Carquinez Straits bridge work, dealt with matters that have already been fully covered in *Engineering News-Record* and need not be repeated here. Dr. Steinman's paper emphasized the difficulty of the foundation problem, which called for deep open-dredged piers, and described the hydraulic brake or buffer between suspended span and cantilever arm to remove the danger of oscillation in earthquakes. Mr. Goodrich showed both slides and moving-picture films of the hoisting of the suspended spans by means of a system of hoist ropes and counterweights, a method never before used. Complete success attended the hoisting; each of the two suspended spans was lifted into place in about two hours.

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Sanitary Division

A paper on a large water supply and purification project, another on an almost equally large sewage-works, three technical committee reports and one report on policy to the executive committee constituted the formal program of the Sanitary Division. The first paper described the $20,800,000 additional water supply for Providence, R. I., and was by F. B. Marsh, deputy chief engineer, Providence Board of Water Supply. The second paper described the design and construction features of the new sewage-works of Akron, Ohio, now about completed at a cost of about $18,000,000 but, according to a statement by H. P. Eddy, not to go into operation for a year or so because of municipal red tape and technicalities.

The committee on sewage-works operation and control, C. E. Keefer, Baltimore, chairman, reported that an inquiry shows that a large percentage of sewage-works are not properly operated, due to inadequate appropriations and to untrained and inexperienced operators. The committee noted as worthy of consideration an extension to other states of recent Ohio legislation authorizing municipalities to charge for the use of sewage systems. The increasing number of short schools for sewage-works operators was also commended. A study looking toward more uniformity in sewage-analysis is being made.

For the committee on filtering materials George B. Gascoigne (in the absence of W. E. Stanley, Chicago, chairman) reported investigations in progress on both coarse and fine material for sewage filters and also on sand for water filters. A number of tables were included in the report. Water filtration laboratories in a dozen cities are collaborating in studies on size and depth of filter sands.

Studies of friction in pipes conveying sewage sludge were reported by the committee on that subject (Langdon Pearse, Chicago, chairman). These studies have been made on special test lines at Chicago, Syracuse and Baltimore. They have dealt with critical velocity and viscosity, taking moisture or solid percentages into account. The results of the studies, as indicated by lantern slide curves and comments by Mr. Pearse and by Glenn D. Holmes, Syracuse, and C. E. Keefer, Baltimore, members of the committee, are conflicting.

For a special committee created to advise the executive committee as to policy regarding acceptance of papers on stream pollution, with special regard to various proposals for the formation of a sewage-works association and related matters, H. P. Eddy, chairman, stated that his committee had advised against the formation of such an association but in favor of giving moral support to a federation of existing organizations dealing with sewage disposal. The committee also recommended that encouragement be given to the presentation of papers before the Sanitary Division on sewage research, on the operation of sewage-works and on processes of treatment, but advised against the acceptance of papers confined to biological or chemical research or to operating data, since such papers can find an outlet elsewhere.

A question having been raised as to the outcome of the proposal for establishing a journal to publish papers on sewage treatment, finally taken in hand by a committee of one hundred as the result of consideration at the recent meetings of the American Water Works Association and the American Health Association, George W. Fuller, New York City, stated his understanding to be that a committee has been appointed to form an organization for the purpose indicated.

Aerial Photo Work in Past Year

In addition to photographs made for purely military training purposes during the fiscal year 1927, the Air Corps of the U. S. Army photographed, for mapping and mosaic purposes, a total area of about 48,000 sq.miles in various parts of the United States. The major portion of this work was divided among government departments as follows:

War Department	3,200 sq. miles
Engineer's Board, Rivers and Harbors	25,000 " "
Geological Survey	16,600 " "
Coast and Geodetic Survey	2,200 " "
International Boundary Commission	1,000 " "

Lesser projects for other bureaus of the departments of Agriculture, Interior, and Commerce were also completed. The total area photographed is more than double that of any previous year. According to the War Department it registers about the maximum limit of the amount of aerial surveys that the Air Corps can accomplish annually under its existing organization and without interference with training.

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Simple Method Used to Lower Cast-Iron Water Main

STREET improvements often lower the surface grade to such an extent that it is necessary to relay water mains so they will be below the frost line. When this occurs in Springfield, Mass., the mains are lowered by the water department in a simple and effective way which does not require the water pressure to be shut off.

The department has a small trench excavator which it often uses on this class of work. The machine is not equipped with an oscillating motion, being only capable of cutting a trench the width of the cutter, or 30 in. When used for lowering mains under pressure, however, trenches 8 ft. wide and 7 ft. deep have been made. The machine is set up to cut a trench along one side of

LOWERING 30-IN. CAST-IRON WATER MAIN UNDER PRESSURE

Trench shown is 8 ft. wide and 7 ft. deep. Excavator cuts 2½ ft. width, while additional width is cut down by laborers and removed from the trench by the excavator.

the main, and follows along the entire length of main to be moved in this relative position. The extra width of trench is cut down by laborers who shovel this material to the excavator as it moves along. The trench is carried to a depth below the pipe on each side of it to the desired depth, and the material underneath the main is removed in short sections, allowing the main to rest on a number of small piers of earth. Usually each pipe length is supported by one pier. Owing to the large amount of material excavated and the relatively small size of the machine used, additional laborers are required on top of the bank to keep the excavated material from rolling back into the trench. When the excavation is in sand, the supporting piers under the pipe gradually give way under the weight of the mains, and it continues to settle to the bottom of the trench. Where the soil is clay, it is necessary for the workman to spade down the supporting piers so as to obtain a uniform lowering of the mains.

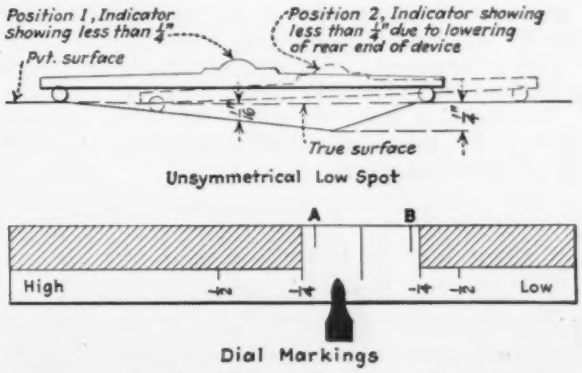
Very little difficulty occurs from leaking joints, and any leaks occurring are easily and quickly repaired. The mains lowered are cast-iron pipes from 4 in. to 30 in. in diam., with both lead and composition joints.

Device Detects High and Low Spots in Concrete Road Surface

By Harold Andrew
Assistant Engineer, Illinois Division of Highways, Peoria, Ill.

WITH a clause in the Illinois specifications for portland cement concrete pavement providing for a surface which shall not deviate more than ¼ in. from the true surface as determined by a 10-ft. straight-edge, it became essential to develop an instrument for testing pavement smoothness which combined efficiency of operation and accuracy of measurement. Several years ago such a instrument was developed in District No. 4, and in five years of use it has proven itself so satisfactory that at the beginning of the 1927 construction season there were nine in use.

The device, called a pavement rater, consists of a wooden frame made up of two parallel members to which cast-iron end wheels are attached. The indicator, carrying a heat-treated steel roller, is swung from the frame at its middle point. Attached to the indicator are steel scrapers, one of which is in front of and the other



DESIGN OF MACHINE TO DETECT IRREGULARITIES IN SURFACE OF PAVEMENT

behind the roller. The end wheels were turned on a lathe within 0.002 in. of true diameter. Adjustable babbitted bearings were used to take up any wear that might occur. The rollers on the indicators were made of such material that there would be no appreciable wear due to being used on hard surfaces.

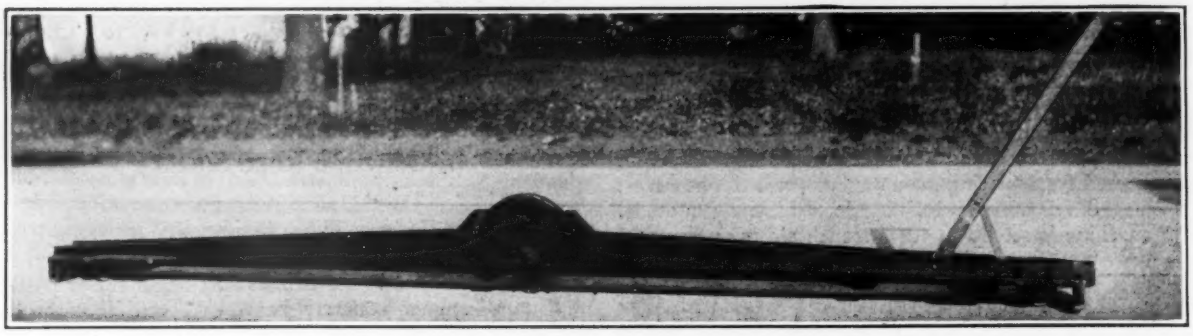
The adjustment of the pavement rater is made by shifting the entire indicator up or down in the frame,

From Job and Office

Hints That Cut Cost and Time

and by changing the position of the scrapers. A fine thread stretched along the bottom of the wheels furnishes the basis for the measurements. If the scraper comes in contact with the surface of the pavement, the point of contact is either high or low, as the scraper indicates. From the position in which the roller is attached to the frame, one scraper indicates the depressions, and the other scraper the high places. These are shown on the graduated dial above the roller by a pointer.

Straight-edging is done by pushing the instrument over the pavement. The pointer standing on the long central mark (see sketch) indicates true surface. The pointer



PAVEMENT RATER IN USE ON ILLINOIS HIGHWAYS

oscillating between marks *A* and *B* indicates waves $\frac{3}{16}$ in. from true surface. When the pointer moves into the black areas, an irregularity of more than $\frac{1}{4}$ in. has been encountered. Detection of such appreciable variations is made more positive by the scraper dragging and producing the scraping noise, or in case of green concrete, by marking the surface. The instrument also shows the dimension of the irregularity from a true surface.

Pavement raters having three indicators spaced $2\frac{1}{2}$ ft. apart have been used. This is to conform with the theory that unsymmetrical high and low places exist on the pavement surface which only a three-indicator instrument could detect. However, after using several instruments of this design for two years, it was found that 99 per cent of the variations were detected by the middle indicator, and for this reason the other two indicators have been eliminated from this machine.

This machine was developed by the writer, assistant engineer, Division of Highways, District No. 4, and its cost is approximately $40.

Procedure in Demolishing a 365-Ft. Brick Chimney

IN FELLING a 365-ft. brick chimney, located at an abandoned plant of the International Nickel Company at Constable Hook, N. J., the contractor experienced several difficulties. However, the same contractor had built the chimney 27 years before and some trouble in demolishing it was foreseen. The plan, therefore, was to discharge successive shots of dynamite, determining the exact method of firing in accordance with the settling of the chimney.

The base of the chimney was constructed of common building brick to a height of about 30 ft. above the concrete foundation. It was square in section on the outside but circular on the inside, so that while the wall was only 5 ft. thick at the center, it increased to a thickness of $10\frac{1}{2}$ ft. at the corners. This made necessary a slightly different arrangement for placing the dynamite than if the base were uniformly round in sections. The diameter at the top of the chimney was 10 ft.

The method of felling the brick chimney was to blast out the brickwork in a horizontal plane, progressively from the side on which the chimney was to fall back toward the center line of the chimney, causing the structure to settle gradually, and finally to tip over from its own weight. In Fig. 2 is shown the effect of the first five shots on the side of the chimney toward which it was to fall.

In all, 161 holes were drilled, placed in three rows and varying in depth from 4 to $6\frac{1}{2}$ ft., being uniformly

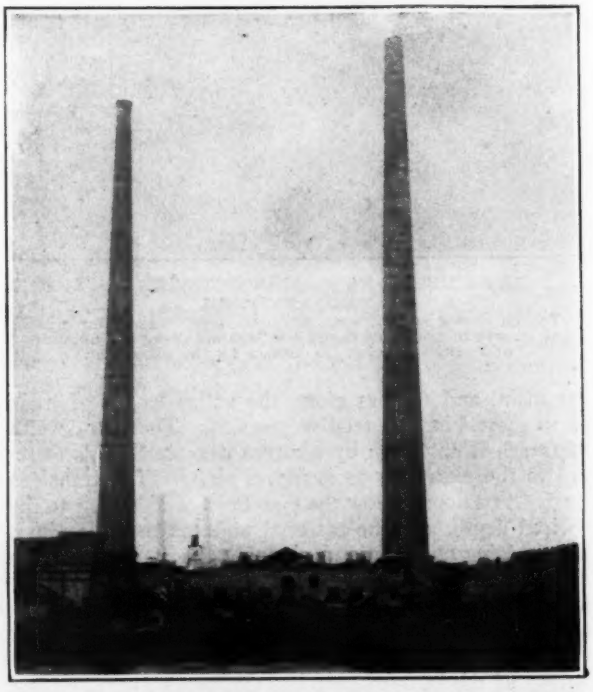


FIG. 1—BRICK CHIMNEY 365 FT. HIGH (ON THE RIGHT) FELLED BY 105 LB. OF DYNAMITE IN 9 SEPARATE SHOTS

From Job and Office

For Contractor and Engineer

1⅜ in. in diameter. About 20 per cent of the brickwork was left on the inside of the chimney to form a sealed chamber for the explosion of the dynamite, the holes on the outside being capped with clay to complete this sealing.

It had been planned to use only 80 of these holes, but 100 holes were necessary to be fired. Also while it was estimated that an average of ¾ lb. of dynamite was necessary for each hole, slightly more than 1 lb. was required. A total of 9 shots was used, the final charge being 45 lb. of 60 per cent dynamite. In all, about 105 lb. of dynamite was used. It was found that the extreme toughness of the brickwork permitted fewer and heavier charges than had first been estimated. Heavy charges ordinarily increase the danger of a chimney collapsing instead of toppling over. As the plan worked out the chimney after the final shot stood in place 13 min. before it toppled over. It measured about 265 ft. of its height on the ground in its fall, after breaking in three places. The contractor was the Alphons Custodis Chimney Construction Company, New York City, Thomas S. Clark, chief engineer.

FIG. 2—BASE OF CHIMNEY SHOWING EFFECT OF FIRST FIVE SHOTS

Holes were placed in the three lines extending around three faces of the chimney.

Power Shovels for Handling Rock Save Time on Rock-Fill Dam

IN PLACING the rock used in facing the upstream side of the rock-fill storage dam on the Bucks Creek project of the Feather River Power Co. in California, some of the larger pieces had to be handled with power equipment. At first this was done by derricks supplemented by power shovels, the latter lifting the large rock fragments by means of chains hooked over the teeth of the dipper. Later three shovels were specially adapted to handling rock by substituting an I-beam for the dipper. This scheme was found very satisfactory and was used throughout the job.

The change on the shovels was made by removing the dipper and bolting an I-beam extension on the outer end of the dipper stick. From a hole near the end of this I-beam a chain was suspended with a hook at its lower end for picking up the chain passed around the rock to be moved. The crowding and swinging movements of the power shovels were found ideal for placing rock, and were said to be more effective on this particular job than locomotive cranes would have been. Three shovels were equipped in this way; two of ¾-cu.yd. and one of 1-cu.yd. capacity. The size of the rock handled varied up to 3 or 4 cu.yd. as a maximum.

PLACING ROCK WITH SPECIAL RIG ON POWER SHOVEL

With these shovels the work of placing such heavy rock fragments as were used on the facing was speeded up very materially. Had it not been for the power shovels it would have been necessary to use enough stationary derricks so that each one would be within the reach of another in order to facilitate removal to new locations as the work progressed. This was unnecessary so long as the power shovels were used as supplementary equipment because they could always aid in moving the derricks to new locations.

Discarded Rims of Truck Tires Make Useful Road Drag

SIX 30x8½-in. discarded motor truck tire rims were used to good advantage by the California Division of Highways as a drag in road work near San Diego, Calif. The rims were chained together in a triangle and used with the apex next to the drag power unit. Being comparatively heavy and compact, this drag was found particularly useful in smoothing up newly-surfaced roads when the material was dry and loose. A valuable feature was that it was speedy and could be

ROAD DRAG MADE FROM SIX OLD TIRE RIMS

dragged along readily at 4 to 5 miles per hour. It had no value for cutting purposes and cannot be used generally for ordinary road maintenance work.

For the accompanying picture of the road drag *Engineering News-Record* is indebted to T. H. Dennis, acting maintenance engineer, California Division of Highways. R. M. Morton is state highway engineer.

Cross-Section Rod and Protractor for Tunnel Work

By Daniel McFarland
Resident Engineer, San Gabriel Dam, Azusa, Calif.

THE tunnels on the Bucks Creek projects of the Feather River Power Company were driven to a section 7½ ft. x 9 ft. 2 in. and lining was not contemplated at first except at the ends, where it was driven to special sizes. When it was found that further lining was desirable the tunnel was accurately cross-sectioned to determine the best section.

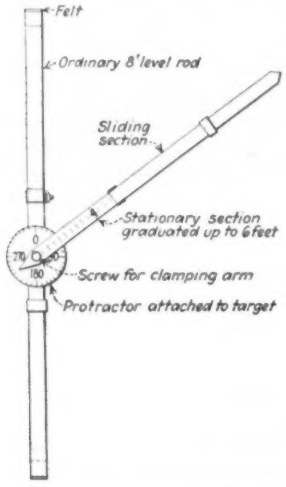


FIG. 1—ROD FOR CROSS-SECTIONING TUNNEL

The rod used for this was an ordinary level rod with a special target that could be moved up or down and clamped in position. This target had a protractor about 16 in. in diameter and a collapsible arm graduated in tenths pivoted on the center of the protractor with a pointer on the opposite side to read the angles.

The transit, set up on the center-line of the tunnel, lined-in the rod. When it was in position the upper part was raised tight against the roof of the tunnel and clamped. A piece of felt gave it a grip on any inclined rock. The target was raised or lowered to grade and the sections taken. The recorder noted the distances and angles.

When these were plotted up transparent cross-section paper was used. The protractor, drawn on white detail paper using black ink, was placed under the tracing paper, making it the work of only a few minutes to plot up a section. The protractor could be drawn up for other scales and other sizes of tunnels.

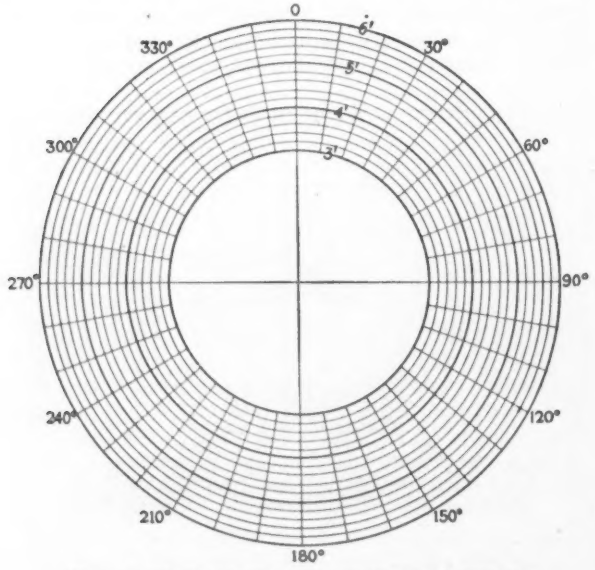
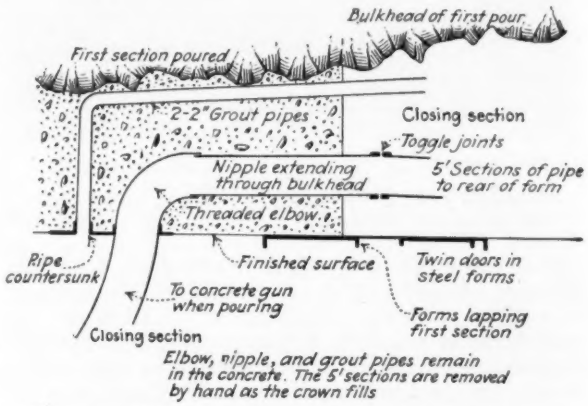


FIG. 2—PROTRACTOR FOR PLOTTING TUNNEL SECTION NOTES

Making Pneumatic Arch Closures in Tunnel Work

By Aaron Evans
Seattle, Wash.

DURING the concreting of the Chelan tunnel, Washington, the most successful method evolved for making arch closures was the following: In the first section poured a threaded elbow and nipple of the delivery pipe were concreted in the crown. Two 2-in. grout pipes were put in as vents. All the pipes extended far enough back to allow for the lap of the form of the closing section, 5-ft. pipe lengths being used. The delivery pipe from the gun was attached to the elbow and the section concreted. The remaining patch is sound and easily made. A reasonably high place in the crown should be selected for rock tunnels.


Bulkhead of first pour
First section poured
2-2" Grout pipes
Closing section
Toggle joints
Nipple extending through bulkhead
5' Sections of pipe to rear of form
Threaded elbow
Pipe countersunk
Finished surface
Twin doors in steel forms
To concrete gun when pouring
Forms lapping first section
Closing section
Elbow, nipple, and grout pipes remain in the concrete. The 5' sections are removed by hand as the crown fills

DETAILS OF GROUT PIPE INSTALLATION

V. G. Hindmarsh was directly in charge for the contractor, Grant Smith & Co. The writer was inspector for T. H. Judd, resident engineer of the Washington Water Power Co.

Bridge Erection Methods

IN A discussion on bridge design at a recent meeting of the Western Society of Engineers it was remarked by Mr. Reichmann, of the American Bridge Company, that ordinary truss spans nowadays are not often erected by means of overhead travelers, but mainly by locomotive cranes having long booms. This latter method saves a heavy investment in the traveler, saves much time and saves many men who would otherwise be required. To the objection that erection by cantilevering is slow on account of the handling of material, Mr. Reichmann replied that this method is not necessarily slow if the plant layout is designed for bringing the material forward rapidly.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Misquoted on Mississippi Flood Problem

Sir—It seems to me that my friend Mr. DeBerard has not quite correctly reflected my attitude on the Mississippi flood problem in his article published in your issue of Dec. 22, p. 1002.

If there be any way whereby the flood stages of the river may be controlled I am in favor of it. I believe that spillways would only afford relief for brief periods and that they will ultimately result in higher flood elevations than would be produced by "levees only."

With a confined river, in my opinion, there will result some scour and enlargement of section, whereby floods of given discharge would be carried with lower gage heights than would otherwise be possible. It does not follow that a larger volume of flow would not establish new gage records.

For example, the maximum recorded discharge at New Orleans in the past was approximately 1,360,000 sec.-ft. If conditions should at some future time bring a flood of say 1,750,000 sec.-ft. to New Orleans, it is certain that the gage reading would be higher than that which was recorded when 1,360,000 sec.-ft. was the discharge.

I feel that so many data are lacking which should be available for a correct solution of the Mississippi River flood problems that all of us are more or less shooting in the dark.

Perhaps a better plan than any thus far submitted would be to send the flow from the White and Arkansas rivers down through the Bayou Boeuf Floodway and then to close the mouths of the White, Arkansas and Old rivers. By this means all of the streams west of the Mississippi River below the St. Francis River would be constituted into another river system with entrance into the Gulf through the Atchafalaya. In such a season as that of 1927, this system would have a discharge of about 1,500,000 sec.-ft. and would be a self-contained system.

Suitable connections for navigation purposes might be made by means of locks with the Mississippi River.

If adequate topographical surveys and maps were available, they might show at once either the possibility or the impossibility of such a project. Even if it be a possibility it would be costly of execution.

If, however, it would afford greater assurance of dependable results, it should be carefully investigated.

The Texas River project referred to by Mr. DeBerard has no direct bearing on the Mississippi River problems. Some information may be gathered therefrom which will be serviceable in the general study of river hydraulics in silt bearing streams.

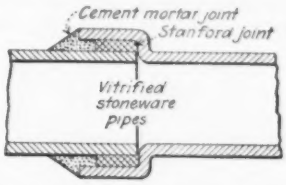
J. F. COLEMAN,
Consulting Engineer.

New Orleans, La.
Dec. 27, 1927.

Use of Sulphur in Sewer Pipe Joints

Sir—With reference to an article appearing in the issue of Sept. 1, 1927, p. 346, relative to a sulphur compound for jointing tile sewer lining for the Los Angeles County Sanitation Districts, the necessary experiments have no doubt been made to justify the use of a sulphur compound and the authorities are presumably perfectly assured that the jointing to the lining will be quite durable. In this connection, however, it may prove interesting to record briefly the experiences at Pretoria, South Africa, with the jointing of vitrified stoneware pipes for conveying sewage. Formerly joints were made similar to the well-known "Stanford" joint as shown in the accompanying sketch. The annular joints on both socket and spigot were cast with a composition of the following average ingredients: 10 parts sand; 5 parts tar; 6 parts sulphur; all mixed and heated to about 250 deg. F. before application. When the pipes were laid in position the final jointing was completed with 1:1 portland cement mortar.

Examination after several years of the lengths of sewers laid in this manner revealed a deterioration at the joints. Some joints were very bad, and as far as it was possible to determine these were made with a larger proportion of sulphur than that mentioned. All the material at the joints seemed to be involved—the cement mortar tended to pulverize and the tar-sulphur compound to lose its quality, while the stoneware pipe also was affected. The defective



VITRIFIED STONEWARE PIPE JOINT

joints formed a small percentage of those examined, but in consequence of these failures it has been deemed advisable to alter the character of the joints for stoneware sewerage pipes and they are now formed by cement mortar only.

Pretoria, South Africa,
Nov. 16, 1927.

J. P. PIKE,
Assistant Town Engineer.

A Landholder's Views on Flood Control Costs

Sir—Referring to that part of the President's message regarding control of the Mississippi River and your editorial entitled "Coolidge on the Mississippi" in the issue of Dec. 8, p. 905.

There has been a very decided effort to have the government bear the entire expense of the proposed protection, and much criticism of the President's views. However, all of us who have interests in the valley do not subscribe to these criticisms. I own and operate a small place almost opposite Vicksburg. This place was so long under water that practically nothing was raised on it this year. Its operation has been an expense without any return.

From my viewpoint, if the government does take over the protection of the valley land it is going to result in very greatly increased values, not at once but eventually. If this view is right, then why should not the owners bear part of the expense of the cost of the improvements? I fail to see where there is any just reason for criticism of the President's position.

LINTON W. STUBBS.

Shreveport, La.
Dec. 15, 1927.

Direct-Hoist Lift Bridge

Sir—In the article on the direct-hoist lift bridge of the Rock Island Lines, in *Engineering News-Record* of Nov. 3, 1927, p. 705, it is stated that the principal advantage claimed is "the elimination of several thousand feet of cable for raising and lowering the span." The inference might be drawn that several thousand feet of operating cable would have been required for this bridge had the usual operating rope scheme been employed. This might be misleading to some of your readers.

A few hundred yards downstream from this bridge there is a highway bridge of our design with a lift span 20 ft. longer than the railway span, with cable operating machinery mounted on the movable span and entirely separate from the suspending sheaves and ropes. The total length of operating cable on this highway span is 1,376 ft. According to usual accepted specifications, eight operating cables would have been required for the railway span, each having a length of half the span, plus the height lifted, plus a margin, or about 165 ft. each. The total would be 1,320 lin. ft., which at about 50c. per foot would cost $660; not a serious item of expense for such a structure.

The scheme of operating machinery placed on the tops of the towers and applied to the main sheaves is not new. In 1909, Waddell & Harrington made such a design for bridge 458 of the Pennsylvania Railroad across the Chicago River. Complete plans were prepared. On the top of each tower there was to be an electric motor with a train of gears engaging the main sheaves over which the ropes suspending the span and counterweights passed. The span was thus to be raised and lowered by the friction of the main suspending ropes on the main sheaves. The motors on the two towers were to be connected electrically so as to synchronize their operation, so that both ends of the span would move alike. There was thus no operating machinery on the movable span itself.

This design provided also for mechanical synchronization between the two towers, so that in case one motor should be out of commission, the motor at the opposite end could operate the mechanism on both towers. Construction was postponed, and in the meantime the rope operation with machinery on the lift span was developed, as in the highway bridge mentioned above. This plan was found to be so much more simple and economical that new plans were made incorporating rope operation, and the bridge was so constructed.

E. E. HOWARD,
Harrington, Howard & Ash.

Kansas City, Mo.
Nov. 29, 1927.

[The above comment was submitted to the engineering department of the railway, which had supplied information for the article in question. The reply is to the effect that "several hundred" feet might have been stated instead of several thousand feet. As to the idea of placing the operating machinery on the towers and applying power to main sheaves on the towers, it is pointed out that no structure today is operated in the same manner as the White River bridge. —EDITOR.]

Paying for Flood Control

Sir—There are so few undisputed facts in connection with the great Mississippi River problem and so much confusion of ideas that a special obligation rests on the engineering profession to keep the interpretation of the existing data coherent.

The writer quotes from your editorial, "Paying for Flood Control," on p. 1029, *Engineering News-Record*, Dec. 29, 1927: "Obviously such a large part of the saving through the protection to be obtained is local that there can be no question of the reasonableness of local participation. The valley states accept that argument for the moment, but come back with the rejoinder that they have already done their share. The Chief of Engineers deals with this argument by presenting a table showing that 63 per cent of the $238,000,000 total spent on flood control since 1822 has been furnished by the states under the present flood control act provisions requiring the local interests to pay one-third the cost of the levee."

If this is the only way the Chief of Engineers deals with the contention of the valley states, it does not appear that he deals with it very effectively.

In the first place, if we accept the figures of Col. C. W. Kutz, member Mississippi River Commission, in *Proceedings*, Am.Soc.C.E., December, 1927, p. 2498, the valley states have paid, not 63 per cent of the total cost to date, but a little more than 70 per cent.

In the second place, the works already completed can be largely utilized in future plans, so that local disbursements upon them in the past may reasonably be credited toward the final project. Assuming that $238,000,000 has been expended to date and that the Chief of Engineers' estimate of $296,000,000 is sufficient to cover proposed extensions, the ultimate cost will be around $534,000,000, of which the valley states have already paid $167,000,000 (according to Col. Kutz).

Thus it is demonstrated that local interests have contributed practically one-third of the total cost of the final project—the ratio established in the existing flood control act and considerably more than the 80-20 ratio suggested by the Chief of Engineers. If the Mississippi River Commission estimate of $684,000,000 for future work be accepted, local contributions would still fall approximately within the Chief of Engineers' ratio. It is rather surprising to discover that the claim of the valley states that they have already done their full share seems to be substantiated, though, for reasons of policy, they should no doubt be required to participate in future right-of-way and upkeep expenses.

The writer wishes to indorse your proposal for a thoroughgoing economic survey to determine what proportion of the 12,000,000 acres of delta land is really worth protection. But let us withhold judgment until specific facts have been gathered. To say that extravagant reclamation is solely responsible for the 31,000,000 acres of farm land that have gone out of use in the United States since the war seems a rash statement indeed. Who can say how much of this land has been ruined and rendered impotent through unscientific methods of culture? Land that has been robbed of fertility by blind practices and allowed to wash away by erosion must of necessity be abandoned, because its restoration is in many cases less economical than the drainage or protection from overflow of adjoining low lands, potentially fertile.

Furthermore, the fact that 3,000,000 farmers have migrated to the cities in the last five years is not prima facie evidence that the land they formerly worked has been abandoned. There are all kinds of farmers, just as there are all kinds of manufacturers and all kinds of merchants. Farming today is in a state of transition, just as industry was in a state of transition in the three decades preceding the close of the last century. Farmers who remain deaf to the call and who fail to keep abreast of the times must of necessity fall by the wayside and yield their land to their more progressive colleagues. Inefficient farming in the past has been made tolerable by rising land values. In the future, farming operations must show a profit *per se* or the operator must go out of business.

So far as the Mississippi Valley is concerned, the whole question is badly in need of prolonged fact-gathering and study. Not until this is done can the violently opposed opinions of our best engineers be adjudicated.

Q. C. AYRES,
Associate Professor,
Iowa State College.

Ames, Iowa, Jan. 5.

What Is Practice in Heating Elevated Water Tanks

Sir—By annexation of a village in 1924, Fargo, N. D., acquired a water-works system including a well, a pump house, and a 0.1-m.g. steel tank on a 100-ft. steel tower. Use of the well supply was discontinued, but the tank was immediately connected with the city system. It acted as an equalizer, providing the only elevated storage in the city's system, in which the pumping station is located at the southerly side of the city and the tank about three miles away near the northerly limit.

The tank has been in service since 1922. To protect the tank riser from freezing a small hard-coal heater (laundry size) had been installed in the pump house about 75 ft. from the tank riser. A 2-in. pipe line, laid underground, carried heated water into the tank. The riser is an 8-in. pipe with six layers of ½-in. matched lumber covering, arranged to give three air spaces. The heating system did not operate when the tank was taken over by the city and for the past three years it has been the custom to cut this tank out of service in winter, when temperatures often go down to —35 deg. F. and for weeks may remain below zero. It is highly desirable to keep this tank in service during the whole year because of the reserve supply and the pressure equalizing effect on the entire city system.

I would like to learn what the practice is in heating elevated tanks and if definite heating requirements have ever been determined for such tanks.

W. P. TARBELL,
City Engineer.

Fargo, N. D.
Dec. 13, 1927.

[The National Board of Fire Underwriters gives elevated tank heater installation details and heating requirements in a pamphlet published in 1926.—EDITOR.]

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Gen. G. W. Goethals, Builder of Panama Canal, Dies at Age of 70

MAJOR-GEN. George W. Goethals, who won enduring fame as the contructor of the Panama Canal, died in his seventieth year on Saturday, Jan. 21, in New York City of cancer. He had been ill for two months, but the fact was known to only a few intimate friends and his death came as a shock to the engineering and business world. The funeral services were held on Tuesday, Jan. 24, in the chapel of the Military Academy at West Point, and the interment was in the historic burial ground overlooking the Hudson.

Gen. Goethals was born in Brooklyn, N. Y., on Jan. 25, 1858. In 1876 he received an appointment to the West Point Military Academy, from which institution he was graduated in 1880, standing second in his class. Being assigned to the Corps of Engineers, his first work in the Army was in the Department of the Columbia under Gen. Nelson A. Miles. Then he was transferred to Cincinnati, Ohio, as assistant in charge of the improvement of the Ohio River for navigation, there gaining his first experience in the construction of canals, locks and dams. From 1885 to 1889 he was instructor, afterward assistant professor, of civil and military engineering in the Military Academy. Then he returned to the work on the Ohio River at Cincinnati and on the Tennessee at Nashville.

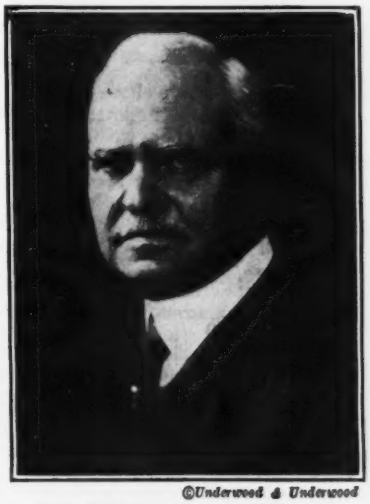
At the outbreak of the war with Spain he was appointed chief engineer of the First Army Corps and served throughout the war.

In 1903 he was called to Washington as a member of the General Staff of the Army, one of the first engineers to receive such an appointment. Here he made a notable record, particularly in connection with fortification construction and the modernization of the coast fortifications. The President and the Secretary of War were strongly impressed with his abilities, and when, a few years later, the selection of an Army engineer to head the Isthmian Canal Commission and take charge of building the Panama Canal was under consideration, Roosevelt and Taft chose Goethals for the work.

Lieut.-Col. Goethals, as he was then, received the Panama appointment in 1907. He remained in the Isthmus nearly ten years.

For seven years Gen. Goethals devoted himself to overcoming the almost insurmountable difficulties of building the Panama Canal. Gold Hill and Contractor's Hill had to be cut through by the famous Culebra Cut, the great earth dam at Gatun had to be built, flights of locks of unprecedented size with their formidable new machinery for gate and valve operation and towing had to be planned and constructed. There were dredging and harbor-construction operations of great magnitude. Shipping and railroad had to be handled at high efficiency. And beyond all the huge, intricately organized working force had to be kept efficient, contented and orderly, under all the disadvantages of location and climate.

Goethals came to the work when the American enterprise had been in prog-



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GEN. GEORGE W. GOETHALS

ress for some years under discouraging conditions. The division of the administrative functions, which were handled by a commission in Washington, from the actual direction of work at Panama, had handicapped progress seriously. Wallace and Stevens had directed operations, but had in turn resigned. But fortunately the most difficult parts of the work had been well prepared for, among them the system of handling the Culebra Cut excavation, the work of Stevens. Goethals, with brilliant executive and administrative ability, and with the joined authority of chairman of the commission and chief engineer, soon placed the enterprise on an efficient, smoothly working basis.

When, late in 1914, the first ship passed through, Goethals remained as Governor of the Canal Zone, but soon prepared to resign. Before he could leave, a series of great slides in the cut closed the canal. He remained to reopen the canal, which he accomplished in six months, and did not finally leave the Zone until the latter part of 1916.

Gen. Goethals at his request was placed on the retired list of the Army, and opened an office as consulting engineer in New York. Within a few months, at the outbreak of the World War, he was called to Washington, as a civilian, to become general manager of the Emergency Fleet Corporation. In this capacity he fought strenuously against the project for building a great number of wooden ships, and in his contest with the Shipping Board made the famous remark that boards are apt to be "long, narrow and wooden." The situation became such, however, that he resigned during the latter part of 1917.

Soon after, he was recalled to active service in the Army, first for a brief period as acting Quartermaster General and then as Director of the Division of Purchase, Stores and Traffic of the General Staff, in which position he was charged with the procurement of all military supplies. For this service Congress awarded him the Distinguished Service Medal. France made him a commander of the Legion of Honor, and he also received medals from the National Geographic Society, the National Institute of Social Sciences and the Civic Forum. In 1919 he was awarded the John Fritz Medal by the American Society of Civil Engineers. Gen. Goethals was a member of the latter society and served as a director in 1918.

Gen. Goethals went back on the retired list of the Army in 1919 and returned to private practice in New York, first as head of the firm of George W. Goethals & Company until 1923, and then under his own name. During this period he served as consulting engineer to the state of New Jersey in the reorganization of the highway department of the state. His firm was retained by the Joint Bridge & Tunnel Commission of the state of New York and New Jersey to report on various tunnel projects; also as consulting engineers on the design and construction of the lock and inner harbor navigation canal at New Orleans. The firm acted as managers for the Wright-Martin Aircraft Corporation and numerous other industrial organizations. More recently Gen. Goethals served as consulting engineer for the Port of New York Authority in its traffic studies and bridge work, including the new Hudson River Bridge.

Chicago Harbor Plans Are Made Public

A comprehensive plan for Chicago's harbor facilities, submitted by Major Rufus Putnam in a report to the Commercial Club, provides for several developments: (1) Enlargement of the existing municipal pier to serve passenger and package-freight vessels and to give better rail and street-car connections; (2) construction of a similar pier and facilities on the opposite (south) side of the mouth of the Chicago River when traffic requires it; (3) a barge terminal with warehouse and trackage facilities on the drainage canal at Crawford Ave.; (4) a barge terminal on Lake Calumet, reached by the Calumet River, serving the trunk-line railways; (5) enlarging the Sag Canal as a connection from this Lake Calumet harbor to the main drainage canal; (6) a lake-front harbor at the mouth of the Calumet River, with piers, warehouses, grain elevators and other facilities suitable for serving both lake and ocean steamers; (7) dredging a navigable channel to connect the Indiana Harbor ship canal (now a stub-end waterway) with the Little Calumet River, and thus with the Sag Canal. The works to be carried out first, as proposed, would be at the Municipal Pier, $1,800,000; Crawford Ave., $1,285,000, and Lake Calumet, $1,247,000, or a total of $4,332,000. The second pier in Lake Michigan, to be built at some future time, is estimated to cost $3,200,000. This report is practically for the city of Chicago, as the Commercial Club offered to have a study of the harbor situation and requirements made by an engineer, and this proposal was accepted by the city authorities.

Land Section Headings of 53rd St. Subway Holed Through

Due to continuous night and day work the headings of the land section of the 53rd St. crosstown subway, New York City, were holed through Jan. 21. The new line will connect the 8th Ave. subway with the Brooklyn and Queens lines at the Long Island City junction. The contract is now 50 per cent complete and the contractor is a year ahead of schedule.

The contract, amounting to approximately $20,000,000, was awarded to the Patrick McGovern Company last spring. Work was started simultaneously on both sides of the East River and at Welfare Island shaft. The construction of the 53rd St. line has now reached the point which permits of a clear walk underground from 8th Ave., to 3rd Ave., a distance of one-half mile on the land area of the contract.

The land section on the Queens borough side of the tunnel is similarly clear of excavated rock and earth, and the section under Welfare Island for a distance of 700 ft. is also clear of rock, leaving only the sections under the two channels of the East River to be excavated. This work will soon be started under air pressure.

Bridge Pier Cylinders Fail and Seven Drown

ON JAN. 19 the falsework for pier No. 6 of the du Pont bridge, under construction across St. Andrews Bay, near Panama City, Fla., failed, throwing the two 16-ft. cylinders into the water, which is about 45 ft. deep at this point. Seven members of the riveting crew, working inside the cylinder, were drowned, the two workmen who were on the outside escaping without injury. There are eleven piers in the main structure and nineteen in the adjacent bay crossing; cylinders for the latter had all been successfully handled on the type of falsework which failed, with no indication of weakness.

A sudden squall with a wind velocity variously estimated at 60 to 80 miles per hour, combined with a heavy running tide, is presumed to have been the principal cause of the accident.

Public Health Officials and Educators Protest Ousting of Dr. Bundesen

Many persons prominent in public health and educational work from the Atlantic to the Pacific, including two university presidents, have issued a statement protesting against the dismissal by Mayor Thompson of Chicago of Dr. Herman N. Bundesen as health commissioner of that city and his replacement by the mayor's personal physician, characterized in the protest as "a physician who, whatever his personal standing, is without apparent qualifications or experience to fit himself for the discharge of the serious duties of the office in question." The protest continues:

Permanence of tenure for competent health officials is an absolutely essential factor in the protection of the public against preventable disease; and the case in question seems particularly flagrant in view of the extraordinary record of Dr. Bundesen, whose brilliant services have aroused nation-wide admiration. Sacrifice of the lives of citizens of Chicago to political exploitation and personal whims is more than a local matter, since insanitary conditions in one community may react upon an entire continent.

The action of the Mayor of Chicago strikes a blow at the most fundamental principles of good government. It should meet with prompt and vigorous rebuke from all people of Chicago who care for the reputation of their city and it should stimulate citizens everywhere to see that city charters are amended so as to make such interference with good health administration impossible in their own communities.

Besides Dr. Bundesen, the protestants state, Mayor Thompson has also eliminated from the city service three other "eminent sanitarians": Dr. J. C. Geiger, deputy health commissioner, I. S. Falk, director of surveys and Arthur E. Gorman, chief sanitary engineer [in charge of the safety of the water supply of Chicago].

Among the signers of the protest are: Two university presidents, Farrand of Cornell and Wilbur of Leland Stanford; four state health officers, Nicoll of New York, Welch of Alabama, Monger of Ohio and Kieffer of Michigan; six local health officers, Chapin of Providence, Harris of New York and also Park, head of the New York Bureau of Laboratories, Vaughan of Detroit, Hassler of San Francisco and Pomeroy of Los Angeles County; six deans and professors of public health, Prescott of the Massachusetts Institute of Technology, Winslow of Yale, Emerson of Columbia (formerly health commissioner of New York City), Abbott of Pennsylvania, Freeman and Howell of Johns Hopkins. Another signer is George E. Vincent, president, Rockefeller Foundation, New York City.

Herminghaus Suit Settled by Power Company Purchase

As a finale to four years of litigation and condemnation proceedings the case between the Southern California Edison Company and the Herminghaus estate was recently settled out of court when the power company purchased the 18,000-acre Herminghaus ranch and thus settled the dispute over the right to store waters of the San Joaquin River in Florence Lake reservoir. The Herminghaus heirs originally obtained an injunction in the Fresno County court against this storage on the ground that impounding these flood waters would prevent the natural periodic overflow of their lands and hence would usurp their water rights. The California Supreme Court upheld the lower court's decision in favor of the complainants and the U. S. Supreme Court on appeal ruled that it had no jurisdiction in the matter. Condemnation proceedings were under way when the case was settled out of court. The purchase price was not announced but is unofficially reported to have been $1,000,000.

Jardine Recommends Highway Planning Commissions

In a speech on Jan. 10 before the National Automobile Chamber of Commerce in New York City, W. M. Jardine, Secretary of Agriculture, recommended establishment of two highway planning commissions—one to lay out metropolitan highways, the other to plan rural systems. Secretary Jardine based his recommendation on the fact that there are in the country today many legally designated public roads which are not needed and which it will be unable to improve for some time to come. He would reduce the mileage and consequently the acreage of land now used for public highways in rural sections, and at the same time plan community and local highway systems to give more adequate service to farm regions. The rural planning commission would work in conjunction with the state highway departments to lay out county and feeder roads to serve agricultural populations.

Washington News

By Paul Wooton
Washington Correspondent,
Engineering News-Record

MAJOR-GENERAL Edgar Jadwin, Chief of Engineers, U. S. Army, is attempting this week to justify his engineering conclusions before the Flood Control Committee of the House of Representatives. Representative Reid, the Chairman of the House Committee and a close political friend of William Hale Thompson, the Mayor of Chicago, is hostile to many of the Jadwin recommendations. He has introduced a bill of his own which apparently has the support of a majority of the members of the committee. Announcement has been made, however, that a minority report will be submitted on the Reid bill and that minority bill based on the Jadwin report will be introduced.

General Jadwin brought out at the beginning of his testimony that the report of the Mississippi River Commission "had reached the committee by the back door" and that it had not been subject to the scrutiny and checking that would have been the case had it been laid before Congress as an official document.

Reports Compared

In comparing his report with that of the Mississippi River Commission he pointed out that by placing the levees on the higher ground in the Tensas Basin it would be possible to reduce the cost of that floodway to $7,700,000, as compared with $35,000,000 estimated by the Mississippi River Commission, and as the area was being given more protection than it had had previously, that no expenditures for land and damages were taken into account. He pointed out also that under his plan $11,900,000 more was being expended for levees in the Atchafalaya floodway than had been proposed by the Commission. General Jadwin indicated his opposition to any plan that would prescribe fixed stages of the river at any point. By putting 900,000 sec.-ft. through the Tensas Basin floodways, he pointed out that lower levees thus could be used on the main river. It was explained that the Army engineers' plan omits a spillway below New Orleans so as to keep down the velocities at that point. All of the engineering plans are in agreement on the advisability of constructing a spillway above New Orleans at Bonnet Carre.

General Jadwin defended the practice of requiring local contributions. He said it would be dangerous to depart from that practice. When asked how it would be possible to get the state of Mississippi, for instance, to contribute money for a project located in Louisiana, General Jadwin expressed the opinion that the states could work that out between themselves just as Missouri and Illinois could work out an apportionment of the cost of the work looking principally to the protection of Cairo. He pointed out, however, that Congress itself had established a policy of local contributions and that his report had been made in conformity to that policy. He called attention to the fact that he had recommended a reduction of the local share from 33⅓ per cent to 20 per cent and had made a provision that the work could be done by the United States in the event the states themselves refuse to co-operate in any vital part of the project.

Hearings before the Senate Committee began Jan. 23. It became apparent immediately that most of the members of the committee are opposed to local participation in the expense of a comprehensive flood-control policy. It was pointed out that practically every government project benefits surrounding property. While no objection was offered to the practice of local contribution on minor projects of doubtful value, attention was called to the fact that the communities on the Great Lakes had been benefited by government expenditures there, but no effort had been made to calculate the amount of benefit to the various ports and no attempt made to allocate a proportion of the cost to them. In like fashion the point was made that government buildings and other government improvements enhance the value of adjacent property, but no effort was made to require contributions from such property.

Walsh Resolution Opposed

Strong opposition to the Walsh resolution proposing an investigation of the electric and gas utilities developed when the Interstate Commerce Committee of the Senate took up the consideration of the measure. In addition to the protests lodged by representatives of the interests concerned and by those of banks and financial houses, representatives of the National Association of Railroad and Utilities Commissioners presented emphatic objections to the investigation by federal authority of the matters which come within their jurisdiction.

Committees in the Senate and in the House have concluded hearings on the Swing and Johnson bills, proposing the construction of a high dam in Black Canyon on the Colorado River. The probabilities are that each committee will report the bill favorably, but it is generally recognized that great difficulties will face the legislation in both the Senate and the House. The general impression seems to be that the proposal in its present form is unlikely to become a law.

Louvain Memorial Fund Now $31,100

It is announced that the total amount subscribed up to Jan. 14 for the fund for the Louvain Memorial to American Engineers is $31,100, from a total of 1,754 subscribers. From the American Society of Civil Engineers there has been received $8,402 from 386 subscribers.

Brief News

Yale Building Construction Students listened to an instructive lecture by W. J. Barney, of the Barney-Ahlers Construction Corporation, of New York, on Jan. 24. The subject was "Relation of Contractor and His Banker."

The Fourteenth Annual Conference on highway engineering will be held Feb. 14 to 17 at the University of Michigan, in co-operation with the State Highway Department and the Michigan Association of Road Commissioners and Engineers. The subjects to be discussed include: Field control of pavement concrete, low cost improved roads, bituminous treatment of gravel roads and earth subgrades, the study of concrete pavements from cost records, snow removal, trends in bituminous pavement design, maintenance and development of roadsides, the personnel of a maintenance organization, roadside clean-up, maintenance equipment and road numbering.

Baltimore Now Has a Personnel Officer, for the first time in the history of the city, in the Department of Public Works, made up of the eleven engineering bureaus of the city. Charles F. Goob, chief engineer and head of the department, has assigned Paul Zimmerman, superintendent of public buildings, to the position.

Amalgamation of the Magazines, *The Nation's Health* and *The American Journal of Public Health* is announced, the combined magazine to be known as *The American Journal of Public Health and Nation's Health*. It will be published under the auspices of the American Public Health Association.

The 20-M.G. Clear Water Reservoir which has been under construction during the past eighteen months by the Detroit Department of Water Supply was put into service on Jan. 5, increasing the clear water reservoir capacity of the city to more than 50 m.g. This unit, which was constructed at a cost of about $1,000,000, is a part of a $30,000,000 program for the extension of the Detroit water-works under George H. Fenkell, chief engineer and general manager.

The John Fritz Medal, which was awarded to Gen. John J. Carty in November, 1927, and the Edison medal, which was awarded to Dr. William D. Coolidge in December, 1927, will be presented to the medalists in the Engineering Auditorium, 29 West 39th St., New York City, on Wednesday evening, Feb. 15, in connection with the annual winter convention of the American Institute of Electrical Engineers. The John Fritz medal will be presented by Robert Ridgway, and an outline of the achievements of General Carty will be given by Bancroft Gherardi. President Gherardi, of the American Institute of Electrical Engineers, will make the presentation of the Edison medal to Dr. Coolidge, and his achievements will be outlined by Dr. Michael I. Pupin.

Plan to Develop Columbia River Given Congress

Two bills for development work in the Columbia River Basin were considered last week by the House Committee on Irrigation and Reclamation which temporarily laid aside the Boulder Dam legislation for hearings on the Columbia River bills. Both bills were introduced into the House by Representative N. J. Sinnot. One provides for irrigation and power development on the Columbia River at Umatilla, Ore., and the other for an irrigation project in the Deschutes River Valley, Ore. The Deschutes bill proposes irrigation of more than 80,000 acres of land now farmed by dry methods. The Umatilla bill provides for irrigation of some 94,000 acres near Umatilla, a power project of 420,000 hp., ultimate development, and construction of a lock chamber on the Columbia River 45 ft. wide, 300 ft. long, with a lift of 57 ft.

Big Increase Predicted in N. Y. Suburban Traffic

In a preliminary report to the associated transit agencies of the port district of New York, the Suburban Transit Engineering Board predicts a 50 per cent increase in suburban traffic before additional facilities can be authorized and placed in operation.

The Suburban Transit Engineering Board is made up of representatives of all the railroads in the port district, the Port of New York Authority, North Jersey Transit Commission, New York Board of Transportation and the boards of supervisors of Westchester, Nassau and Suffolk counties. It was organized last summer following enactment of a law in New Jersey directing the port authorities to take up the suburban transit problem.

It was agreed that the first step must be the preparation of a comprehensive and workable physical plan.

Bill in Congress Would Create Pan-American Road Commission

A bill to create a Pan-American Highway Commission has been introduced into Congress by Representative Dowell of Iowa, Chairman of the House Committee on Roads. By the terms of the bill a commission would be created composed of the Secretary of State, the Secretary of Agriculture, the Secretary of Commerce and four individuals to be appointed by the President. This commission would work out and study matters relating to the establishment of highway communication with the republics south of the Rio Grande and co-operate with these republics at their invitation in helping them to work out highway and transportation problems. An appropriation of $25,000 is carried to pay for the work necessary. It is provided that this commission may make use of agencies, officers, and employees in the government's executive branch.

Foundation Bids Opened for N. Y. City State Building

Bids were opened Jan. 10 by the State Office Site and Building Commission of which Governor Smith is chairman for excavation and foundation work for the new state office building in New York City, to be located on a site north of the new county court house, bounded by Centre, North and Baxter Sts. J. L.

McDonald Construction Co., New York City, was low bidder with $244,900; John Condon, Long Island City, was second with a bid of $259,776. Bids will be received for the superstructure on Feb. 14.

The new building will be nine stories in height of pure classic style of architecture, of brick, steel and granite material with bronze windows and flat roof. It will contain approximately 500,000 sq.ft. of office space and will house all of the state departments located in New York City.

Denver Water Board Vacancies Filled After Two Years

Vacancies on the Denver Water Board since September, 1926, have been filled by the appointment of William H. Leonard, president of the Gardner-Denver Company, a recent consolidation of the Denver Rock Drill Company and the Gardner Governor Company, of Quincy, Ill., and Frederick R. Ross, a real estate and investment broker heading the Ross Investment Company. During the period of these vacancies there have been only three members on the board.

To Award Apprenticeship Certificates

At a recent meeting of the New York Building Congress, Stephen F. Voorhees, chairman of the appreticeship commission of the congress, announced that this year every boy who completes his trade course will receive a certificate of apprenticeship. A citation will be placed on the certificates of those boys who receive the Fenner prize, awarded in commemoration of the late Burt L. Fenner, former member of the firm of McKim, Mead & White, architects. The co-operating trades are carpentry, electrical, upholstery, bricklaying, plastering, plumbing in the Borough of Queens, granite cutting and marble cutting.

Phenol Tastes in Buffalo Water Supply Being Investigated

Recent bad tastes and odors in the water supply of Buffalo, N. Y., are being investigated by Earl Devendorf, assistant sanitary engineer, acting under the direction of C. A. Holmquist, chief of the division of sanitation, State Department of Health, and Dr. Edwin M. Clark, sanitary supervisor for the Buffalo district of the department. Bryan J. Boyle, water commissioner of Buffalo, and other local officials, attribute the taste and odors to phenol wastes from the plants of the Donnar-Hanna Coke Corporation, the Bethlehem Steel Company and the National Airline & Chemical Company, but this is denied by each of the companies.

Hughes to Report to New York on Delaware Water Project

Employment of Charles E. Hughes and John W. Davis to give opinions on the interstate legal aspects of the proposed plan for an additional water supply from the Delaware River for New York City has been authorized by the Board of Estimate and Apportionment. The board has given tentative approval of the plan; has authorized application to the State Water Power and Control Commission for its approval, the introduction of a bill in the New York Legislature for a charter amendment enabling the Board of Water Supply to extend its operations into Delaware, Sullivan and Ulster counties, and the giving of [illegible] to the governors of Pennsylvania [illegible]ew Jersey of the intention of New [illegible]ity to go to the Delaware River for water.

It is understood that no larger expenditures will be authorized by the Board of Estimate until after the opinions of Messrs. Hughes and Davis have been rendered. The report on the Delaware River project by Thaddeus Merriman, chief engineer, Board of Water Supply, was abstracted in *Engineering News-Record*, Aug. 11, 1927, p. 218.

Illinois Society Offers Prizes

To develop the activities of young engineers, the Illinois Society of Engineers has offered a "president's award," consisting of two cash prizes of $50 and $25 for the junior members not over 25 years of age who "possess and display in the greatest degree the qualities of initiative, self-reliance and originality" during 1928, these qualities being combined with good judgment and a proper knowledge of the fundamentals of engineering science. Each candidate for the award must be recommended or endorsed by two members in a detailed statement submitted before Jan. 1, 1929, and these statements will be passed upon by a committee consisting of the president and two past-presidents.

H. E. Babbitt, Urbana, Ill., is secretary of the society.

Tube Under the Oakland Estuary Is "Holed Through"

The Oakland estuary tube was "holed through" on Jan. 9 when the temporary bulkhead in the last concrete segment was broken open and engineers and officials of the two cities passed through the tube from portal to portal. This tube, which is 3,545 ft. long between portals, passes under the estuary between the cities of Oakland and Alameda, Calif., and consists of twelve segments that were built in drydock on the opposite side of San Francisco Bay, floated into position, sunk into place and connected up under water.

Work yet to be done includes removing the remaining parts of several bulkheads, pouring the ceiling, backfilling the trench, completing the ventilating buildings and installing equipment. All outside joints between segments, made with tremie concrete, have been poured and even through these joints there is only a very small amount of leakage. At joints where the inside lining has been poured and the joints grouted, there is reported to be practically no leakage.

Contract for the construction of the tube was awarded to the California Bridge & Tunnel Co. on a bid of $3,882,958, which did not include portal buildings or equipment. Work was begun June 15, 1925, with a time limit of 900 working days. On Jan. 10, 1928, the elapsed time was 794 days with 94.7 per cent of the work on this contract completed. The tube is expected to be ready for traffic before the first of July. Although the design of the tube was for a double-track street railway, with rail heads flush with the pavement, it is now stated that the street car company will probably employ large motor buses instead of street cars for operating through the subway.

An article on construction of the tube appeared in *Engineering News-Record*, Jan. 19, p. 100.

Building Accidents Increasing, Building Congress Told

James A. Hamilton, Industrial Commissioner, state of New York, told the members of the New York Building Congress at its monthly luncheon meeting on Jan. 19 at the Hotel Commodore, New York, that accidents in the building industry during the last four years increased in number, while in manufacturing they have been in general decreasing.

"It is high time that the building industry was tackled in a systematic and thoroughgoing way as to accident prevention, as has been true of manufacturing industries for a considerable period of time," he said. "When the problem is taken up in that way, there is every reason to believe it is only a question of sufficiently extended effort of that kind to produce very important results, such as have been brought about actually in the iron and steel industry."

November Storm Topic at New England Water Works Association's Luncheon

Three papers on the heavy rainfall in New England, Nov. 3-4, 1927, were presented at the luncheon-meeting of the New England Water Works Association, Jan. 11. In addition, L. M. Hastings, city engineer, Cambridge, Mass., read a paper on lining the Payson Park reservoir with gunite, to stop leaks that have been going on for twenty years. Mr. Hastings' paper will be summarized in a later issue of *Engineering News-Record*.

The first of the rainfall papers was presented by X. H. Goodnough, chief engineer of the Massachusetts Department of Public Health. A rainfall map of New England for the total storm was shown, similar to that prepared by Prof. H. K. Barrows, as published in *Engineering News-Record*, Nov. 17, 1927, p. 796, but with some changes in detail due to the addition of a few records in Vermont particularly that at Garfield (7.9 in. for the storm), and in southwestern Rhode Island (9 in. at Westerly) not available at the time of Professor Barrows' investigation.

Storms of Earlier Days

Mr. Goodnough also gave interesting data regarding storms of magnitude in New England, in addition to those of 1869 and 1897, described by Professor Barrows. That of Oct. 12-14, 1895, centering in Massachusetts, attained a maximum rainfall of about 8 in., but owing to previous dry weather resulted in little damage. The storm of Feb. 10-14, 1886, in southeastern New England, reached about the same maximum rainfall of 8 in., but the runoff was much greater owing to melting of snow, which contributed about 2 in. more of water. In August, 1826, occurred the storm causing the Willey House slide, as it is called, in the Crawford Notch in New Hampshire. Little detail of the rainfall at that time is available, but at New Bedford the monthly total was 18.72 in., the maximum of record. Still earlier, in October, 1785, occurred a storm in New Hampshire which probably equalled in effect that of 1896 on the Merrimack River, the latter giving the highest recorded flows on this river.

Mr. Goodnough suggested the probability of other great storms at earlier times of which no records are available, but which were less disastrous in effect owing to the undeveloped character of these regions at the time. He also pointed out that based upon past performance a great storm approximating that of November, 1927, might be expected in New England on the average once in about 20 years.

J. Henry Weber of Clark University presented an interesting paper, prepared jointly with Prof. Charles F. Brooks, describing the three meteorological factors which resulted in the great storm of November, 1927. The first of these was a large supply of damp tropical air that happened to be on tap over the Gulf Stream and the Atlantic to the southward. It was marked by low pressure on the weather maps for a few days preceding the flood. The second factor was the piling up of a great and almost immovable mass of air in the East, from Maine, Nova Scotia and Newfoundland eastward. This was marked by high pressure on the maps. The third was the southward flow of a considerable body of cold air into northern New England and along the Appalachian ranges and through their valleys to the Middle Atlantic coast. After three days of northward flow of the tropical air, funnelled into western New England between the air masses on the east and on the west, such great masses of damp air were forced together and up over the obstructing mountains and their northern and western higher bulwarks of cold air, while at the same time being overturned by the cold air above, that unprecedented quantities of water fell in a short time.

H. B. Kinnison, district engineer at Boston of the U. S. Geological Survey, described the work of his department in obtaining data of flood flow for the recent storm. Fieldwork for this purpose was begun during the flood and already data for records of flood runoff at some 125 points in New England have been procured. This information, when in completed form, will be published in a special Water Supply Paper, which it is hoped to have available in a few months, and will serve as base data for future flood studies.

Albany Engages Engineers for Gravity Water Supply

The Board of Water Supply of Albany, N. Y., with approval of the Board of Estimate and Apportionment, has retained Whitman, Requardt & Smith, engineers of Baltimore, Md., with Robert E. Horton, consulting engineer of Albany, N. Y., to design and construct the proposed new Hannacrois-Basic gravity water-supply system for Albany. The project includes the development of about 12,000 m.g. storage on Hannacrois Creek; a diversion dam on Basic Creek, with a tunnel of 200-sec.-ft. (130-m.g.d.) capacity leading from Basic Creek into Hannacrois Creek; a 45-m.g.d. conduit from Alcove intake on Hannacrois Creek to Albany, a distance of about 20 miles; a 30-m.g.d. filter plant on the line of the conduit; and a new 100 m.g. concrete uncovered distribution reservoir at Albany. The immediate development will provide a minimum supply of 30 m.g.d. which it is expected will be made available within 3 years, replacing the present pumped and filtered supply from the Hudson River. It is expected that bids for parts of the work will be invited in February. The works now to be constructed comprise the first stage of a comprehensive plan recommended by Mr. Horton in a report to the Board of Water Supply of Albany, dated October, 1925.

Personal Notes

A. R. Cook, assistant chief engineer of the Northern Pacific Railway, at Seattle, Wash., has retired, under the pension rules. He began his railway service in 1885 as assistant engineer on the Chicago, Burlington & Quincy Railroad, and was successively with the Minneapolis, St. Paul & Sault Ste. Marie Railway, the Great Northern Railway and the Northern Pacific Railway. He was made engineer of maintenance-of-way for the Pacific lines of this last road in 1908, and was advanced to assistant chief engineer and engineer of maintenance-of-way in 1923.

Einar Weidemann, assistant engineer of bridges for the Pennsylvania Railroad, at Chicago, has been appointed engineer of bridges and structures, with the same office.

A. F. Stotler, district engineer of the Northern Pacific Railway, has been appointed assistant chief engineer and engineer of maintenance-of-way, with office at Seattle, Wash., succeeding A. R. Cook, retired.

G. I. Hayward succeeds A. F. Stotler, promoted, as district engineer of the Northern Pacific Railway at Seattle, Wash. H. M. Tremaine succeeds Mr. Hayward as district engineer at Spokane, Wash.

Elbert H. Dresser has been appointed chief engineer of the Duluth, Missabe & Northern Railway, at Duluth, Minn., to succeed the late W. H. Hoyt.

Clinton S. Herrick, senior assistant engineer of the Bureau of Engineering, Syracuse, N. Y., has been appointed chief engineer of the Grade Crossing Commission of Syracuse, N. Y. Mr. Herrick is a graduate of Syracuse University and began service in 1899 with the Chicago & Alton Railroad and was connected with various railroad companies in this country and in South America until 1908. In that year he entered the civil service of the city of Syracuse and has remained in it ever since, except from 1914 to 1917, when he was a senior civil engineer with the Interstate Commerce Commission.

Herbert S. Cleverdon, Edward A. Varney and Waldo F. Pike, announce their association under the firm name of Cleverdon, Varney & Pike, for the practice of structural engineering in Boston.

J. B. Converse, for the past eight years an associate of J. W. Billingsley, consulting engineer of New Orleans, has accepted a position as chief engineer of Mobile County. This county is carrying on a $6,000,000 highway and bridge improvement program.

L. M. Brumfield, formerly resident engineer for the North Dakota State Highway Commission, is now resident engineer of the Sandusky Bay Bridge at Sandusky, Ohio, for the firm of Harrington, Howard & Ash, consulting engineers of Kansas City, Mo.

Joseph B. Shaw, formerly assistant city engineer of Utica, N. Y., has been appointed general assistant city engineer of Syracuse, N. Y., effective Jan. 1.

G. A. Draper, former maintenance engineer of the Mississippi State Highway Department, was made state highway engineer Jan. 1, 1928. He replaces H. C. Deitzer, who resigned on that date. Mr. Draper is a native of Mississippi, was graduated from the University of Mississippi in engineering in 1908 and has been with the Mississippi State Highway Department since 1919.

J. H. Wasson, until recently field engineer for the Portland Cement Association, has accepted a position as engineer-representative with the newly-formed Peerless-Egyptian Cement Company of Detroit, Mich.

T. S. Edminster and E. H. Cove, well known in engineering and construction circles in San Antonio, Texas, have associated themselves together under the firm name of Edminster & Cove for the general practice of engineering, though they will specialize in city planning, platting and subdivision work. Mr. Edminster has been practicing engineering for about twenty years, and previous to going to Houston was associated for seven years with George E. Kessler, landscape architect and city planner, Kansas City and St. Louis. Mr. Cove received his engineering experience at Northeastern University, and since that time has been connected with several firms, including the Steel Company of Canada, Ltd., and the New York, New Haven & Hartford Railway.

Engineering Societies

Calendar

Annual Meetings

NATIONAL ASSOCIATION OF BUILDERS' EXCHANGES, Washington, D. C.; Annual meeting, Miami, Fla., Feb. 6-9, 1928.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Monday, Feb. 14-16, 1928.

ASSOCIATION OF HIGHWAY OFFICIALS OF NORTH ATLANTIC STATES. Trenton, N. J.; Annual Convention, Atlantic City, N. J., Feb. 15-17, 1928.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Convention, Philadelphia, Feb. 28, 29 and March 1, 1928.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Convention, Chicago, March 6-8.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION; Annual meeting, University of North Carolina, June 25.

The Chicago Association of Consulting Engineers, composed of engineers engaged in mechanical, electrical and sanitary engineering, principally in regard to building construction and equipment, has re-elected its officers for 1928 as follows: President, Irving E. Brooke; vice-president, Ernest V. Lippe; secretary, Rollo E. Gilmore, 104 So. Michigan Ave.

The New York State Association of Builders held its 32nd annual convention in Syracuse, N. Y., on Jan. 24, 25 and 26. Among the addresses were: One by Col. William M. Acheson, chief engineer, state of New York; "Minor Injuries and Compensation Insurance," by Benjamin G. Stallman, of Rochester; "Safety Work in New York City," by C. G. Norman, of New York; and "The Advantages of Quantity Survey," by G. Szmak, chairman of publicity committee, American Institute of Quantity Surveyors. There was also a discussion of the legislative program for 1928.

The Society of Engineers of the San Francisco Bay District held its regular monthly meeting on Jan. 10. Election of officers for the ensuing year resulted as follows: President, Philip Schuyler; vice-president, Glenn B. Ashcroft; treasurer, William G. Rawles; secretary, Albert J. Capron; directors, Hans Graff and Albert A. Robish. The society is now two years old and has a membership of 503.

The American Water Works Association announces meetings of local sections as follows: Canadian Section, at London, Ont., March 7 to 9; Indiana Section, at Purdue University, Lafayette, Ind., March 15 and 16.

The Detroit Engineering Society at its meeting on Jan. 20 listened to an address on "The Economic Significance of Modern Engineering" by Dexter S. Kimball, dean of the College of Engineering, Cornell University.

The New Jersey Sewage Works Association will hold its annual meeting at the Stacy-Trent, Trenton, N. J., on March 23 and 24.

The Association of Highway Officials of North Atlantic States will hold its fourth annual convention in the Hotel Ambassador, Atlantic City, Feb. 15 to 17. Besides an interesting program of papers and discussions, there will be an exhibition of highway materials, equipment, etc., by leaders in the highway industry.

The Duluth Engineers Club held its annual meeting on Jan. 17, and re-elected its officers and directors as follows: President, J. A. Noyes; first vice-president, C. R. Jacobus; second vice-president, F. B. Cronk; secretary, H. W. Richardson; treasurer, F. C. Ballus; directors, William Constable, L. M. Pharis, Martin Hokanson and E. E. Atkins.

The Providence Engineering Society met on Thursday evening, Jan. 26, and listened to a talk by Frank E. Waterman, Commissioner of Public Works for the city of Providence, on "Municipal Incinerator Plant for the Disposal of Garbage and Combustible Refuse."

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Cleveland Is Host to Largest Road Show—II

Exhibits of Highway Equipment and Materials Eclipse All Former Records—Second Class Roads Equipment Increases and Transportation Developments Are Notable

Engineering News-Record Staff Report

This is the second and concluding article reviewing the exhibits of equipment and materials shown at the Road Show in Cleveland Jan. 9-13. The first article appeared in these pages Jan. 19.

Transportation

HIGHWAY machinery such as power shovels, cranes, pavers, pumps, compressors and batching plants are well established on the road to adequacy in production. There has remained the ever increasing problem of disposing of their output, of supplying them with materials, of making them more mobile, and of transporting them rapidly from place to place. Equipment for these purposes—trucks, trailers, tractors, industrial locomotives and crawler units—was the predominant note at the 1928 show.

Trucks—Range in truck sizes shown was from 1 ton to 3 tons, the lighter units for maintenance work and small tool hauling, and the larger trucks for heavier construction work. Both the Ford Motor Company and the Chevrolet Motor Company exhibited their new truck models with various types of bodies. The Ford Model A 1½ ton truck uses the regular Ford engine, but a special arrangement of transmission which provides about 70 lb. more tension on the clutch spring.

The most unusual truck development at the show was the application of crawler units for rear traction. The Republic Truck Sales Corporation exhibited its Linn tractor with a rear crawler unit featuring a lubricating system which operates automatically every mile. On this model no weight of the tractor or load is carried on the axle, and all wearing parts are made of 12 per cent manganese steel. The company also exhibited a 3-ton Republic truck with underbody scraper, and a new model truck with a special spring, known as a helper spring, to take severe shocks and rebounds. Lombard Tractor and Truck Corporation exhibited an entirely new designed model of its tractor truck with rear crawlers. The crawler track is made of a special nickel chrome molybdenum steel, the treads so designed that either cleats or rubber pads can be attached as desired: The machine has four speeds forward and one reverse. Outside of the rear crawlers the main feature of the tractor is the front axle pivoted at the center on a spring supported saddle. It is designed so that the truck can go over extremely uneven ground without tilting the body or throwing unequal loads on the wheels or springs. Maccar Truck Company introduced a high speed crawler unit using a solid rubber tread belt running over two cast steel wheels. A speed of 35 m.p.h. was claimed for this equipment. To reduce the twists and strain which uneven ground causes in engine and cab, the Indiana Truck Corporation exhibited a new truck in which the radiator hood and cab are mounted with a three point suspension. The unit has a capacity of two 7-bag batches and is operated with a 5 speed transmission; a seven speed transmission was used on the company's 3-ton maintenance and gravel hauling truck which was exhibited. The O'Connell Motor Truck Company exhibited its 5-ton two-way drive five-speed gear-drive truck with a vertical steering column and dual control. A new 5-ton chain drive model using an 80-hp. Waukesha truck was also shown in the two-way drive model.

Relay Motors Corporation showed pneumatic tires and four-wheel brakes for the first time on its new Model 1½ ton truck, using its system of two rear axles, a floating live axle, and fixed wheel axle, the whole arrangement claiming to eliminate stalling in rough and soft ground. White Company exhibited its Model 52 truck using an auxiliary transmission, combining the dumping mechanism with an extra low gear for soft-ground haulage. The company also showed a 2½-ton short wheelbase truck and a 1-ton dump truck for road maintenance work. Acme Motor Truck Company exhibited a new 2½-ton truck, Autocar Sales and Service Company a new 3-ton 6-cylinder model, in addition to its regular line, the Four Wheel Drive Auto Company a new six-cylinder engine truck with 5-speed transmission and 3-ton dump body, the General Motors Truck Company a new model vibrationless 2-ton truck with a worm drive and a 6-cylinder Buick engine, and a new 2½-ton general utility truck, and Graham Bros., Inc., its 2-ton truck using a 6-cylinder engine and special short wheelbase for road building construction. Other motor truck exhibitors included the Federal Motor Truck Company, the Reo Motor Car Company, the International Harvester Company, the Gotfredson Truck Corporation, the Selden Truck Corporation, and the Le Blond-Schacht Truck Company.

Truck cranes were exhibited by the Universal Crane Company and the Buckeye Traction Ditcher Company, the latter company showing a new crane mounted on a Mack truck. The Universal Crane Company showed a new 52-ft. boom made up of its standard 28 ft. boom, a special 8 ft. base, and a 16 ft. boom-head extension. It also exhibited for the first time a new ¾-yard power shovel attachment for the crane unit. The company has introduced during the past year on its models a detachable crawler unit, making a crawler truck with six rear wheels. It is claimed that the crawler can be propelled at ordinary truck speeds and is more flexible than the usual type crawler unit. Removing the crawlers the truck becomes an 8 wheeled unit, the crawlers being carried on brackets for use whenever necessary.

Two trucks were shown for hauling ready-mixed concrete. The Hug Company showed its 2- and 3-ton road builder trucks with special springs carrying the load to the frame ahead of the rear axle thus relieving shock and making for easier riding, and in addition exhibited a new rear dump body for wet concrete. When this body is tilted the sides separate from the bottom insuring a clean dump, while cross pieces through which the concrete must fall remix the batch as it is dumped. The Clinton Motors Corporation exhibited a truck mounted with a 3-yd. capacity revolving drum body for hauling ready mixed concrete. The drum was revolved by a separate gasoline engine and no paddles of any kind were used in it. This type of truck is being used on some sections of the New York subway construction.

Bodies and Hoists—In the field of hoists, the Heil Company exhibited a new hydraulic hoist for small bodies which features only two moving parts these operating in a bath of oil. Other companies exhibiting hoists were the Hydraulic Hoist Manufacturing Company and the Wood Hydraulic Hoist and Body Company, the latter company showing both its hydraulic and mechanical hoist line. Many small capacity steel bodies were shown for use on the new Ford and Chevrolet trucks. Some of the companies exhibiting this type of equipment were the Ditwiler Mfg. Co., the Anthony Co., which company also showed a body for mounting on the Wehr Fordson grader, Hughes-Keenan Co., Galion All Steel Body Co., and the Superior Body Corporation. Closed cabs were exhibited by the Metropolitan Body Company and the Highland Body Manufacturing Company. Heavy duty bodies were shown by the Differential Steel Car Company, and the Commercial Shearing and Stamping Company, both showing a three-way dump body. The Differential dump body is operated by a

mechanical three-way hoist built around a ball and socket joint. The body of the Commercial Shearing and Stamping Company, on the other hand, is hydraulically operated.

Trailers—The 1928 Show witnessed the advent of crawler-mounted trailer units. The outstanding examples of these were the seven-yard all-steel bottom dump wagon of the Western Wheeled Scraper Company, and the rear-dump hydraulically-operated all-steel trailer of the Athey Truss Wheel Company. Several other companies exhibited crawler units for smaller trailer use. The heavy duty transport trailers in 35 and 40 ton capacities of structural steel construction were exhibited by several companies. Rogers Bros. Corporation showed its 35-ton trailer unit improved with a compressive-spring drawbar support. The Highway Trailer Company showed a 40-ton trailer and in addition a new 4-wheel trailer using steel castings in place of structural parts in the fifth wheel. Other heavy duty trailers were exhibited by the Freuhauf Trailer Company and Chas. Hvass & Company.

Tractors—Heavy duty tractors up to 10-ton sizes were shown by the Monarch Tractor Corporation, the Electric Wheel Company, showing both a 5-ton and 10-ton model, and the Cleveland Tractor Company exhibiting a new 100 hp. machine incorporating the company's patented steering mechanism, which operates the same as on a motor car, traction being maintained on both tracks at all times. This latter model also uses a one-shot oiling system lubricating with one push of a plunger the entire system of track wheel bearings on both sides. The Caterpillar Tractor Company exhibited its "20," "30" and "60" models and the Bates Manufacturing Company showed a number of improvements on its 40-hp. tractor. The Trackson Company exhibited its full-crawler Fordson unit, and also showed tractors equipped with a snow plow, a shovel, and a crane boom for pipe handling. Other exhibits of tractors included the J-T Tractor Company, International Harvester Company with its 10-20 and 15-30 McCormick-Deering tractors, and the Ford Motor Company with a new Fordson using a high compression head and special ratio gears claimed to give 23 per cent more power to the motor and 17 per cent more power to the drawbar than in the old model.

Industrial Locomotives—There were only two exhibits of industrial locomotives but the one of the Fate-Root-Heath Company contained one of the outstanding developments at the show in the form of Diesel application. This company exhibited a 15-ton locomotive powered by one of the new Buda Diesel engines, and likewise an 8 ton gasoline model. An Atlas-Imperial Diesel engine was used on the company's 12-ton locomotive. All models shown used a four-speed gear drive. The Brookville Locomotive Company exhibited a model of its industrial locomotive built around the Fordson tractor.

Operation

Snow Equipment—Several new pieces of equipment for snow removal were exhibited. The Klauer Manufacturing Company featured an operating model of its Snogo snow machine, a complete truck unit with a screw conveyor bringing the snow from the sides to the center of the road and a suction and blower unit which discharges it at a considerable distance to the side of the road. The blower and conveyor unit are operated by a power plant separate from that of the motor truck. The Joy Manufacturing Company exhibited a new snow machine developed from its many years experience in coal handling. The new machine is a portable belt conveyor with two mechanical raking arms at the bottom which gather the snow to the center as the conveyor is pushed along by its motor truck mounting. It is claimed the machine is so balanced that it passes over street obstructions with ease. The Walter Motor Truck Company exhibited an especially equipped snow truck with four-wheel drive and a 100-hp. motor. The unit is equipped with two plows, one in front which throws the deep snow from the road and another beneath the body which removes all snow and ice down to the pavement; a differential three-way dump body is used on the truck. The Gifford-Wood Company showed an ice leveler, a scarifier unit to be drawn behind a tractor. George Haiss Mfg. Company, Inc., and N. P. Nelson Iron Works, Inc., showed their bucket loaders for snow removal work. The Wassau Iron Works exhibited its V-type snow plows for all models of Caterpillar tractors. Galvanized iron snow fence was exhibited by the Northfield Iron Company.

Traffic Control—Equipment for traffic control such as signs, flashing signals, truck-wheel scales, highway fence and guard rails, and line marking machines were exhibited. Wallace & Tiernan showed a new flashing signal with automatic bulb changer, the whole unit operating on dry batteries. Standard Traffic Maker Company exhibited rubber signs for insertion in pavements; a vehicle passing over such signs bends them to the street from which they immediately rebound to upright position. American Gas Accumulator Company exhibited its flashing signal, its automatic and manual control signals for city streets and its patented reflector signs. Other companies showing signs and signals were the Harrington-Seaberg Corporation, the National Colortype Company and the Rog-Signs Corporation. Black and Decker exhibited its Loadometers for truck-wheel load weighing, and Fairbanks Morse & Company showed its recently developed scale for the same purpose. A new line painting machine was exhibited by Littleford Bros., which includes a brush for cleaning the surface and a marking roller fed by a small automatic pump which regulates the flow of paint to the speed of the marker. Other markers were exhibited by the Simons Paint Spray Brush Company and the Tennessee Tool Works, Inc.

Highway fence and guard cable were exhibited by the American Steel and Wire Company, Cyclone Fence Company, MacWhyte Company, Page Steel and Wire Company, and the Wickwire-Spencer Steel Company.

General Exhibits

Engines—A new Diesel engine in 4- and 6-cylinder models was shown by the Buda Company, being manufactured under rights secured from the M.A.N. company in Germany. The engine is a solid-injection high-speed light-weight 4-cycle unit with 6-in. bore and 8-in. stroke developing 92 b.hp. The Climax Engineering Company varied its past policy by showing its engines connected to pumps forming complete units. A new development on the company's engines is the incorporation of an automatic spark advance. The Continental Motors Corporation exhibited its new Series A engines, which have been made more compact, and also a new six-cylinder overhead valve series of engines. The Hercules Motor Corporation featured a new heavy duty six-cylinder engine with a seven-bearing crankshaft using 3-in. main bearings. The Le Roi Company exhibited its complete line of power units, most of them mounted on welded steel frames. The Minneapolis Steel and Machinery Company exhibited its Twin City models in units from 4½ in. x 6 in. to the huge 7¾ in. x 9 in. size. Other companies exhibiting engines included the Fuller & Johnson Mfg. Company, Wisconsin Motor Manufacturing Co., Waukesha Motor Company, Universal Motor Company, Stearns Motor Mfg. Company, Servel Manufacturing Co., and the Novo Engine Company.

Small Tools—In the field of small tools there was introduced a new line of hydraulic oil-power jacks by the Black Hawk Mfg. Company, and a gasoline operated pavement breaker, by the Milwaukee Gas Tool Corporation. Shovels, spades, picks, and other tools were exhibited by the Wyoming Shovel Works, the Conneaut Shovel Co., the Ames Shovel & Tool Co., the Baldwin Tool Works, and the Cleveland Hardware Company. Wrenches were exhibited by Heller Bros. Company and the Snap-On Wrench Company. The MacLeod Company exhibited carbide lights, concrete heaters, tar heaters, and a sand blast machine. Wheelbarrows and concrete buggies were shown by the General Wheelbarrow Company and bomb-shell flares for night construction work and as warnings at highway openings were exhibited by the Toledo Pressed Steel Company.

Fabricating Equipment—Each year records a growth in the number and variety of exhibits showing equipment used as fabricating parts in highway construction machinery. Steel and alloy

steel castings adaptable to use on practically the entire list of highway equipment was shown by the Western Crucible Steel Castings Company, Taylor-Wharton Iron and Steel Company, Sivyer Steel Casting Company, Ohio Steel Foundry Company, Nugent Steel Casting Company, National Malleable and Steel Castings Company, Kensington Steel Co., Farrell-Cheek Foundry Company, Eberhard Mfg. Co., Commercial Steel Casting Company, American Manganese Steel Company, Alloy Cast Steel Company, and the Park Drop Forge Company.

Worm-gear driving units were shown by the Timken-Detroit Axle Company, power take-offs and clutches by the Twin Disc Clutch Company, rear truck axles and differentials by the Eaton Axle and Spring Company featuring herringbone double reduction axles for 2½- to 3½-ton trucks, transmissions and gears by the Brown-Lipe Gear Company, clutches and transmissions by Fuller & Sons Mfg. Co., bushings and bearings by the Bunting Brass & Bronze Company, and roller bearings by the Timken Roller Bearing Company and the Hyatt Roller Bearing Company. Pierce Governor Company exhibited its product, Simplex Piston Ring Company of America showed various types and sizes of piston rings, and the Zenith-Detroit Corporation exhibited carburetors for industrial machines, these being especially equipped to eliminate dirt, and to operate at extreme tilting angles.

Magnetos were exhibited by the Splitdorf Electrical Company, by the Eisemann Magneto Corporation, by the Robert Bosch Magneto Company, and by the American Bosch Magneto Corporation. Wire rope was shown by the Williamsport Wire Rope Company, by A. Leschen & Sons Rope Company, and the W. S. Tyler & Sons Company exhibiting wire for use in shaker and screening plants. Speedometers, tachometers and similar equipment was shown by the A. C. Spark Plug Company. Wheels for tractors, trucks and buses were exhibited by French & Hecht, Whitehead & Kales, Geneva Metal Wheel Company, Erie Malleable Iron Company and the Dayton Steel Foundry Company. The Prefex Corporation, formerly the Racine Radiator Company, and the Young Radiator Company exhibited heavy duty industrial radiators for highway machine service. The Prefex Corporation exhibited a new radiator for paving mixer service with large air passages to prevent clogging.

Miscellaneous — There were several types of equipment that did not fit into the above classifications, or else were so generally used as to be inclusive of several of the classification headings. The Lufkin Rule Company exhibited a large stock of its various types of rules and tapes. The Everhot Manufacturing Company exhibited branding equipment for marking company names on tools. Woodworking machinery was exhibited by the Jones Superior Machine Company and the Dewalt Products Company.

Trolleys and hoists were shown by the Chisholm & Moore Manufacturing Company. Motor street sweepers were exhibited by the Butler Manufacturing Company and the Elgin Corporation. The D-A. Lubricant Company exhibited its special lubricant for heavy duty machinery, while the Dot Lubrication Division of the Carr Fastener Company exhibited its adjustable pressure cup for delivering grease uniformly for from four to seven days, and its new electric motor-driven lubricator with a capacity of 25 lbs. of grease or oil. Wall ties, wire column clamps, and similar equipment was shown by Al. J. Hodapp, and the M. & M. Wire Clamp Company.

Lathes and steel working machinery were shown by the South Bend Lathe Works, and a highway mowing machine by the Rawls Mfg. Company. Tinius Olsen Testing Machine Company exhibited a brick tester, a cement tester, and a briquette machine. Small electric lighting plants were shown by the Kohler Company, and McKiernan-Terry Drill Company showed operating models of its pile hammers. The Metalrut Company exhibited sections of heavy gauge corrugated troughs held in parallel position by corrugated struts, the whole to be used as a roadway over soft ground. Another new product was shown by the Rapid Pavement Breaker Company, being a truck mounted air operated hammer for tearing up pavements and other road surfaces.

Exhibits were also maintained by the Textile Bag Manufacturers Association, by the Pittsburgh Testing Laboratory and by the Equipment Corporation of America, the latter showing its rebuilt equipment.

New Corporation Holds Option to Purchase Paver Company

Financial interests in Milwaukee have organized the National Equipment Corporation, incorporated in Delaware, for the purpose of purchasing and holding a controlling interest in several equipment companies in various parts of the country. It is said that the new corporation now holds an option for the purchase of a controlling interest in the T. L. Smith Company, paver manufacturers of Milwaukee. It is understood that the option will be exercised some time during January, 1928. Among those interested in the new holding company are Harold E. Smith, president, T. L. Smith Company; Philip Koehring of the Koehring Company, construction equipment manufacturers in Milwaukee; Joseph E. Uihlein, Robert Uihlein, and others whose identity has not yet been announced. It is stated that the officers, directors and management of the T. L. Smith Company will continue as heretofore.

Concrete Road Yardage

For December the square yardage included in concrete pavement contract awards according to the Portland Cement Association was 4,657,326 for roads; 1,679,299 for streets, and 204,990 for alleys; or a total for the month of 6,541,615 sq.yd.

The accompanying table summarizes the statistics for the current year:

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1927

Month	Roads	Streets	Alleys	Total All Classes
Jan.	2,656,118	1,504,059	75,352	4,235,529
Feb.	2,336,031	1,935,262	119,382	4,390,675
March	5,134,974	3,866,102	298,667	9,299,743
April	10,264,336	4,931,954	285,924	15,482,214
May	8,234,755	5,601,627	397,220	14,233,602
June	8,424,051	6,977,602	673,350	16,075,003
July	7,298,618	4,903,789	412,721	12,615,128
Aug.	10,725,030	5,820,033	479,369	18,024,432
Sept.	6,872,398	4,365,135	343,270	11,580,803
Oct.	5,527,085	3,686,570	586,575	9,800,230
Nov.	5,102,195	2,614,285	267,979	7,984,459
Dec.	4,657,326	1,679,299	204,990	6,541,615
Totals	77,232,917	47,885,717	5,144,799	130,263,433

Manufacturers and Trade Associations

Calendar

Annual Meetings

AMERICAN WOOD PRESERVERS ASSOCIATION, Chicago; Annual meeting, Montreal, Canada, Jan. 24-26.

NATIONAL PAVING BRICK MANUFACTURERS ASSN., Chicago; Annual meeting, Chicago, Jan. 25-26, 1928.

NATIONAL BRICK MANUFACTURERS ASSOCIATION, Danville, Ill.; Annual meeting, Atlantic City, Feb. 8-12.

New Publications

Water Purification — BURNS & McDONNELL ENGINEERING COMPANY, consulting engineers, Kansas City, has issued a 32-page booklet, being the story both in text and illustrations of some of the important projects undertaken by this company in all parts of the United States in the field of water purification. The booklet's purpose as conceived by its authors is to "further encourage municipalities to better domestic and industrial water supplies."

Wire Rope—A. LESCHEN & SONS CO., St., Louis, Mo., has issued a useful booklet entitled "Practical Information on the Use and Care of Wire Rope." It is a revised edition of the original published in 1920. Such subjects are discussed as breaking in a new wire rope, kinking, lubrication, type of sheaves to be used, rope capacity of drum, care of rope in alkalis and acids, binding ends of rope, applying wire rope clips, and re-socketing.

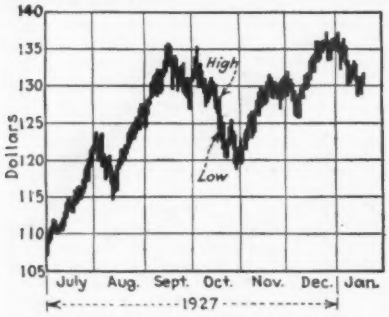
Steel Fittings — STOCKHAM PIPE & FITTINGS CO., Birmingham, Ala., has published a 24-p. catalog describing its steel fittings for superheated steam, and other high pressures and high temperatures. The catalog contains dimensions of all types of fittings.

Business Side of Construction

Facts and Events That Affect Cost and Volume

New Index of Industrial Stock Prices

From the 1,092 stocks listed on the New York Stock Exchange (on Dec. 1, 1927) *The Annalist* has selected eight issues and weighted them inversely according to their average ranges. The theory of this weighting is to give each stock an equal influence on the average of all. To be eligible as a market leader a stock must have a heavy normal volume of trading and move consistently with the market. The 1926 and 1927 transactions in these eight issues made up 20 per cent of total transactions in industrial stocks.



WEIGHTED AVERAGE OF EIGHT LEADING STOCKS COMPUTED BY THE "ANNALIST"

The table gives the stocks selected and their weights. In the event of shifts in market leadership of any of the issues, substitution will be made. The number of the stocks will be increased or decreased as circumstances seem to warrant, proper statistical adjustment being made to assure continuity of indication. The chart shows the daily fluctuation of this index from July 1, 1927, to date.

THE ANNALIST INDEX OF STOCK MARKET LEADERS

	Weight
General Motors	25
United States Steel	20
Allied Chemicals	10
American Can	10
American Smelting	10
Hudson	10
Mack Trucks	10
Woolworth	5
	100

Foreign Projects of Interest to American Contractors

Further information on the following items may be obtained from the Bureau of Foreign and Domestic Commerce, or its district and co-operative offices, by American contracting firms qualifying for the Exporters' Index. Where no reference number is given, further information is unavailable.

Subway, Manchester, England, construction recommended in report of municipal railways committee, £11,000,000, reference, England No. 60,179.

Railway, East Java, changing of Baloeng-Rambipoedji line, State railways, 50 kilometers, from narrow gauge to standard, Netherland East Indies State Railways, Bandoeng, Java.

Superstructure, Spencer St. Bridge, Melbourne, Australia, plans being drawn, steel girder, cantilever type (preferably), central span 112 ft., side spans 104 ft., pylons at abutments.

Drainage, Struma Valley, Greece, bill authorizing Government to negotiate with bidders, awaiting ratification by Chamber of Deputies.

Road program, Australia Country Road Board will expend £2,675,000 on road construction and maintenance during the current fiscal year, 1927-28.

This Week's Contracts

Heavy construction contracts reported by *Engineering News-Record* in the week ended Jan. 26, with some comparisons, total as follows:

(In Thousands of Dollars, 000 Omitted)

Week Ended	Public	Private	Total
Jan. 26, 1928....	$10,407	$21,943	$32,350
Jan. 19, 1928....	14,132	31,879	46,011
Jan. 27, 1927....	17,040	37,175	54,215
Jan. 1 to date:			
1928.....	74,748	128,235	202,983
1927.....	64,439	117,301	181,740

E. N.-R. Index Numbers

Cost		Volume	
Jan. 1, 1928	203.90	December, 1927	319
Dec. 1, 1927	203.90	November, 1927	272
Jan. 1, 1927	211.50	December, 1926	188
Average, 1927	206.24	Average, 1927	263
Average, 1926	208.03	Average, 1926	228
1913.....	100.00	1913.....	100

Steel Advance Is Principal Price Change for Week

For the second time since November, steel prices advanced 5c. per 100 lb. at Pittsburgh, to $1.85, on Jan. 19. This price covers bars, structural shapes and plates. Sheet prices also have risen, blue-annealed, 5c. per 100 lb.; galvanized, 10c.; black, 20c. In automobile sheets there is much cutting under the $4 per 100 lb. base.

Steel mills are operating at 74 to 78 per cent capacity, compared with 60 per cent in December. Bulk of the demand is from the railways and automotive and construction industries.

Cement in San Francisco has dropped 10c. to $2.41 delivered. Hollow tile at Montreal moved from 10c. to 12c. per block, 4x12x12 in. Linseed oil at Chicago and Minneapolis advanced 1.5c. per 7½-lb. gal.

For complete list of prices see pp. 45 to 48, *Engineering News-Record*, Jan. 5, 1928.

Foreign Trade in First Nine Months of 1927 and 1926

Foreign trade while brisk in the first nine months of 1927, gaining volume in a number of products, also fell off considerably in other items. The chief export gains were in lumber, asphalt, paints and varnishes. Rails totaled 137,000 gross tons, a gain of 4.8 per cent. Rail production in all 1926 totaled 3,217,000 tons, of which 5.8 per cent was exported. Cement exports amounted to 0.5 per cent of production in the first nine months, a decline of 18 per cent; imports, though amounting to 1,230,000 bbl., declined 44.6 per cent from 1926. Other noteworthy declines were in structural steel exports (14 per cent), and railway track materials except rails (22 per cent). The exports table gives other details.

Imports gained chiefly in iron and steel products; bars and ingots declined 23 per cent. See imports table.

(000 Omitted)

EXPORTS

Material	—Jan. 1 to Oct. 1— 1927 Pounds	1926 Pounds	Per Cent Gain (+) or Loss (—)
Boards, planks....	5,238,114	4,702,096	+11.4
Sawed timber.....	1,806,783	1,784,954	+ 1.2
Steel plates, sheets	1,490,070	1,417,572	+ 5.1
Logs, timber.....	752,587	523,057	+43.9
Asphalt (petroleum)	617,519	218,613	+182.5
Steel pipes.....	508,105	512,824	— .9
Structural steel...	358,134	417,615	—14.2
Steel rails.....	307,066	293,014	+ 4.8
Steel bars.....	229,796	273,710	—16.0
Cement (hydraulic)	228,315	277,587	—17.8
Paints, varnishes..	151,962	125,454	+21.1
Steel wire.....	134,999	147,579	— 8.5
Track material, except rails.....	56,713	72,644	—21.9
Doors (wood, number).....	1,662	1,193	+39.3
Railway Ties (number).....	2,980	2,929	+ 1.7

IMPORTS

Material			
Cement (hydraulic)	575,416	1,038,398	—44.6
Structural steel...	268,040	189,069	+41.8
Steel pipes.....	252,117	166,764	+51.2
Steel bars.....	183,485	239,238	—23.3
Plate glass (sq.ft.).	13,177	20,376	—35.3
Boards, planks (M. ft.).....	1,341	1,390	— 3.5
Lath (thousands)..	1,435	1,466	— 2.1
Logs, timbers (M. ft.).....	190	124	+52.9
Poles, (thousands).	595	578	+ 3.1
Shingles (thousands)	1,484	1,893	—21.6

Current Bond Offerings

		Interest Rate	Yield	Due
Asheville, N. C.	$750,000	4½	4.30	Dec. 1, 1944–66
Bridgeport, Conn.	760,000	4	3.50	Feb. 1, 1929–68
Buenos Aires	3,396,000	6	6.10	Oct. 1, 1960
Greenwich Water Co.	1,225,000	4½	4.40	July 1, 1957
High Point, N. C.	1,500,000	4½	4@4.30	Jan. 1, 1930–48
Honolulu, T. H.	1,000,000	5	3.95	Jan. 15, 1933–57
Hudson River Regulating District	2,170,000	4½	4.10	July 1, 1935–65
James River Bridge Corp.	4,500,000	6½	6.50	Jan. 1, 1958
Kenton County, Ky.	500,000	4½	4	Jan. 1, 1933–56
Lexington, N. C.	112,000	4½	4.40	Jan. 1, 1931–61
Lexington Water Power Co.	12,000,000	5	5.10	Jan. 1, 1968
	5,000,000	5½	5.60	Jan. 1, 1953
Manatee County, Fla.	400,000	5½	5	July 1, 1933–57
Middlesex Water Co.	1,000,000	5½	5.30	Apr. 1, 1957
Port of N. Y. Authority	12,000,000	4	3.878@3.937	Jan. 3, 1938–53
Northwest Eng. Co.	2,500,000	6	6	Jan. 1, 1938
Obion County, Tenn.	465,000	4½	4.25	Oct. 1, 1947
Oklahoma City	8,629,000	4@4½	4@4.15	Feb. 1, 1931–53
State of Vermont	5,000,000	3½	3.75	Dec. 1, 1929–48
Waterbury, Conn.	650,000	4	3.50@3.82	1929–68